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AN INTEGRATED NATIONWIDE ENVIRONMENTAL MONITORING SYSTEM

Environmental Protection Agency
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AN INTEGRATED NATIONWIDE ENVIRONMENTAL MONITORING SYSTEM ✓

OFFICE OF MONITORING

ENVIRONMENTAL PROTECTION AGENCY

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AN INTEGRATED NATIONAL ENVIRONMENTAL MONITORING PROGRAM

INTRODUCTION

Environmental monitoring is one of the keys to effective management of environmental quality. Monitoring support is essential in most stages of pollution abatement--from initially identifying environmental problems to finally providing direct evidence in enforcement actions. Decisions based upon monitoring results are far reaching, requiring a comprehensive data base that is both accurate and reliable. This means that strong and dynamic monitoring programs must be developed at all levels--local, State, and Federal.

The formation of the Environmental Protection Agency (EPA) brought together the various environmental protection programs and with them the monitoring activities supporting these programs. These monitoring activities must now be forged into an integrated nationwide environmental monitoring system. The need for a system to provide a comprehensive appraisal of the total environment--air, water, and land--has long been recognized. The importance of establishing this capability was cited in the President's message to Congress regarding reorganization plan No. 3. Similarly, the EPA Monitoring Task Force, in its findings dated 28 May 1971, urges that a mechanism be established to bring together the activities that are essential to total environmental assessment.

The present monitoring program of EPA consists of a number of separate monitoring activities inherited from parts of the various agencies brought together within the Environmental Protection Agency. For the most part, these monitoring programs are not directly applicable to solving EPA's current requirements for monitoring because many were implemented before a statutory need for monitoring information existed. These early programs were aimed at identifying changes in concentrations of pollutants in a specific segment of the environment and the capability for total environmental appraisal is limited. Furthermore, adequate methodology and instrumentation have not been fully available for making absolute measurements, and even after several decades of operation, some data from these monitoring programs are not reliable.

The purpose of this document is to summarize current monitoring activities and present a strategy for developing an integrated nationwide environmental monitoring program. The discussion addresses the need for coalescing some of the existing environmental monitoring activities, implementation of a quality control program, and the establishment of a central environmental data information system. The discussion is supported by seven appendices which provide more detail on the material covered.

MONITORING NEEDS

Definition of Monitoring

The Office of Monitoring has defined environmental monitoring as the systematic collection and evaluation of physical, chemical, biological and related environmental data pertaining to environmental quality and waste discharges into all media. It may be performed through the operation of regional, nationwide and global networks and special studies of individual areas and sites. Monitoring includes the following types of activities:

1. Field sampling and measurement of environmental quality, emissions, and effluents.
2. Laboratory analysis of field samples.
3. Operation of technical information systems and data analysis.
4. Measurement sensor and technique development and testing.
5. Instrumentation and methodology standardization and quality control.

Data Uses

There are four types of monitoring systems that can be established to meet the four basic data needs of EPA. These in order of highest priority are:

1. an Environmental Surveillance System* to support the compliance and regulatory activities e.g., detection of violators of the permit program.

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*Surveillance is systematic monitoring, but the word surveillance implies suspicion of violation.

2. an Administrative Monitoring System to provide information on environmental programs, e.g., the status of implementation plans for meeting air and water quality standards.

3. an Ambient Monitoring System to support control and abatement actions, to aid in decision and policy making, to identify research needs, to evaluate health and social effects of pollution to identify trends and possible problem areas and to provide for dissemination to the public of information on the status of the environment.

4. a Research Monitoring Program to support research activities which are usually established on a specific problem basis including the identification of new pollutants to aid in the study of particular problem areas, e.g., establishment of cause/effect relationships.

More information on the four types of monitoring systems is provided in Appendix 1, Attachment 1. Except for differences in the measurement grid, geographical coverage, and temporal considerations, there is no sharp distinction among the activities involved, and to some degree all four types of systems may use elements from a common data base. Perhaps, the most distinguishing characteristic serving as a basis for sub-categorizing these monitoring needs is the duration (i.e., long-term or short-term) of the monitoring activity required to meet a given need. A certain amount of long-term monitoring is required in order to meet each of the above data needs. Short-term monitoring is usually necessary in the assessment of a specific problem or situation that has been identified through long-term monitoring or other means. Long-term monitoring activities can be planned well in advance and carried out in accordance with a predetermined schedule. Short-term monitoring, however, is often carried out in response to unforeseen events and generally cannot be planned far in advance.

Data collected through monitoring activities provide information for:

1. the assessment of pollution effects on man and his environment,
2. the study of pollutant interactions, baselines, and patterns,
3. the establishment and enforcement of ambient environmental quality and emission/effluent standards,
4. the evaluation of the effectiveness of adopted control procedures and preventative measures,
5. the guidance of future development to minimize pollution impact on the environment through the use of modeling and planning (including land use and transportation planning),
6. defining research needs.

Data Integrity

In large measure the success of an environmental pollution control program rests upon the reliability of the data provided by monitoring activities. Meaningful assessments of environmental quality, whether they be within one or among several environmental media, require valid data. When such assessments are made in support of an enforcement action, the data used must be legally defensible. That is, the data's validity must be clearly demonstrable to the satisfaction of a court of law.

The acquisition of reliable, comparable, and legally defensible data requires EPA-wide use of a set of standardized measurement and calibration procedures, an interlaboratory quality control program, a laboratory performance certification program, and a standardized laboratory record-keeping procedure. These serve not only to ensure data uniformity and reliability, but also to document the quality of the data produced. An active standardization and quality control program employing the above elements are sufficient to prevent effective challenges of EPA monitoring data by those accused of environmental pollution.

Statutory Authority for Monitoring

The derivation of the needs of the monitoring program come directly from the legislative and statutory requirements for which EPA is charged. This includes both existing and pending legislation. Appendix 1, Attachment 2 is a listing of legislation existing or pending in Congress, indicating where monitoring is required.

EXISTING EPA MONITORING PROGRAM

The monitoring activities within EPA are highly fragmented and widely dispersed. Seven separate offices (An eighth program, Noise, is planning for monitoring in the near future.) maintain monitoring programs, in most cases, including laboratories, data processing/ storage and technique and instrumentation development capabilities. Within the offices, the monitoring activities are further divided among divisions and projects. The net result is that some monitoring is being conducted under 80 separate program elements managed by 44 individuals. There is little uniformity among these separate offices in the manner in which the monitoring programs are carried out and there are no formal linkages among the individual data/information systems.

In FY72, an estimated 43 million dollars and over 1400 man years of effort are programmed in support of monitoring or monitoring-related activities. This constitutes approximately 20% of EPA's manpower and 15% of its funding. The resources for these activities programmed by each of the eight Program Offices are given in Table 1. Further breakdowns by type of monitoring category are given in Tables 2 and 3.

Monitoring activities may be classified into five distinct categories:

- environmental monitoring
- pollution source monitoring
- information systems and data analysis
- standardization and quality control
- technique development

TABLE 1 - RESOURCES PROGRAMMED TO SUPPORT MONITORING IN FY72 BY OFFICE

	Manpower		Funding	
	Man Year	% of Total	$1000	% of Total
OFFICE OF RESEARCH AND MONITORING	334	24	15,581	36
OFFICE OF AIR PROGRAMS	236	16	10,590	25
OFFICE OF WATER PROGRAMS	404	28	8,181	19
OFFICE OF PESTICIDES	280	19	4,698	11
OFFICE OF RADIATION	76	5	1,569	4
OFFICE OF SOLID WASTES	24	2	662	2
OFFICE OF NOISE	0	0	0	0
OFFICE OF ENFORCEMENT	75	5	1,830	4
	1,439	100	43,111	100

TABLE 2 - RESOURCES PROGRAMMED TO SUPPORT MONITORING IN FY72 BY CATEGORY

	Manpower Man Year	Funding $1000
ENVIRONMENTAL	519	13,067
POLLUTION SOURCE	330	10,452
INFORMATION SYSTEM	330	6,310
TECHNIQUE DEVELOPMENT	226	11,419
STANDARDIZATION AND QUALITY CONTROL	35	1,863
	1,439	43,111

TABLE 3 - RESOURCES PROGRAMMED TO SUPPORT MONITORING IN FY72
(In Million Dollars)

	ORM	OAP	OWP	OPP	ORP	OSW	ONP	OE
ENVIRONMENTAL MONITORING	4.0[1/]	2.2	3.1	1.5	0.6	0	0	1.8
POLLUTION SOURCE MONITORING	0	6.6	1.7	1.9	0.2	0	0	0
INFORMATION SYSTEMS	0.2	1.0	2.5	1.3	0.7	0.6	0	0
TECHNIQUE DEVELOPMENT	9.8	0.7	0.9	0	0	0	0	0
STANDARDIZATION AND QUALITY CONTROL	1.6	0.1	0	0	0.1	0	0	0
	15.6	10.6	8.2	4.7	1.6	0.6	0	1.8

1/ Includes 2 million dollars from AEC for off-site monitoring

NOTE: Zeros may indicate a minimal level of activity rather than no activity.

Environmental Monitoring

About a third of the resources are currently utilized for environmental monitoring which includes comprehensive long-term network operations as well as support of special projects. Both, field sampling and laboratory analysis are considered in this category. The major programs are the nationwide long-term monitoring networks: National Air Surveillance Networks, Water Quality Surveillance Network, National Soils Monitoring Program (for pesticides), and the National Environmental Radiation Monitoring Program. These four programs, operated independently, contain over 20 specific networks and include over 5000 sampling/monitoring locations throughout the country. Total resources for FY72 for network operations are estimated at 260 man years and 5.7 million dollars.

Examples of special projects and short-term studies are monitoring at spill sites during the correction period, nationwide monitoring of pesticides in food, water, air, and soil to support health studies and studies supporting enforcement actions. Collectively, these monitoring activities require 259 man years and 7.4 million dollars in FY72. It should be noted that the AEC Off Site Radiological Monitoring Program with FY72 resources of 2 million dollars is shown as part of the environmental monitoring activity.

Pollution Source Monitoring

Pollution source monitoring includes the field monitoring and sampling and laboratory analysis of stack emissions, automobile exhaust, and waste water discharges from municipal treatment plants and industry. Examples of projects in this area are the source sampling and laboratory analysis activities supporting the new source performance standards, the measurement of exhaust from autos and aircraft to support new standards, monitoring of effluents from municipal treatment plants and monitoring effluents from nuclear facilities. In FY72, EPA is spending 10.5 million dollars and 330 man years of effort in monitoring pollution sources.

Information Systems

In the broadest context, this category includes the operation of national environmental data systems as well as collection and analysis of information previously classed as administrative monitoring. Examples of environmental data systems are National Aerometric Data Information Service (NADIS) and Water Quality Control Information Storage and Retrieval System (STORET). Examples of administrative monitoring are Fuel and Fuel Additive Registration and Market Surveillance for Pesticides. The resources programmed in FY72 for this entire activity are 6.3 million dollars and 330 man years of effort. The FY72 resource requirements for environmental data systems, operation, data processing, and report preparation activities--the items of primary interest in environmental monitoring--are about 2.5 million dollars and 160 man years.

Only two major environmental information systems presently exist in EPA--NADIS for aerometric data and STORET for water data. Work is now underway on the development of information systems for meeting radiation, pesticide, and solid waste data handling needs. Currently, the latter data processing needs are met through manual and computerized data files.

NADIS already has over 250 communities and all states providing air quality data in a standardized format to EPA on quarterly basis. The National Aerometric Data Bank (NADB), the hub of NADIS, is operational and is returning processed information to all contributors on a quarterly basis. The NADIS concept, which is illustrated in Figure 1, is not yet totally implemented in terms of the State processing centers and transmission facilities.

The file structure and formats for STORET provide means of storage and retrieval of water quality data (Figure 2). The file structure and software for retrieval and use of information is now used by 104 terminal locations (24 are located in State Pollution Control Agencies).

There are no formal linkages between and among the existing environmental data information systems. Such crosswalks are essential to the assessment of effects of pollution on the total environment.

Standardization and Quality Control

Some effort is underway in standardization of instrumentation and methods for measurement of air and water pollutants including radiation and pesticides. Similarly, several quality control programs are either operating or are being developed on an independent basis. In FY72, only 35 man years of effort and less than 2.0 million dollars are

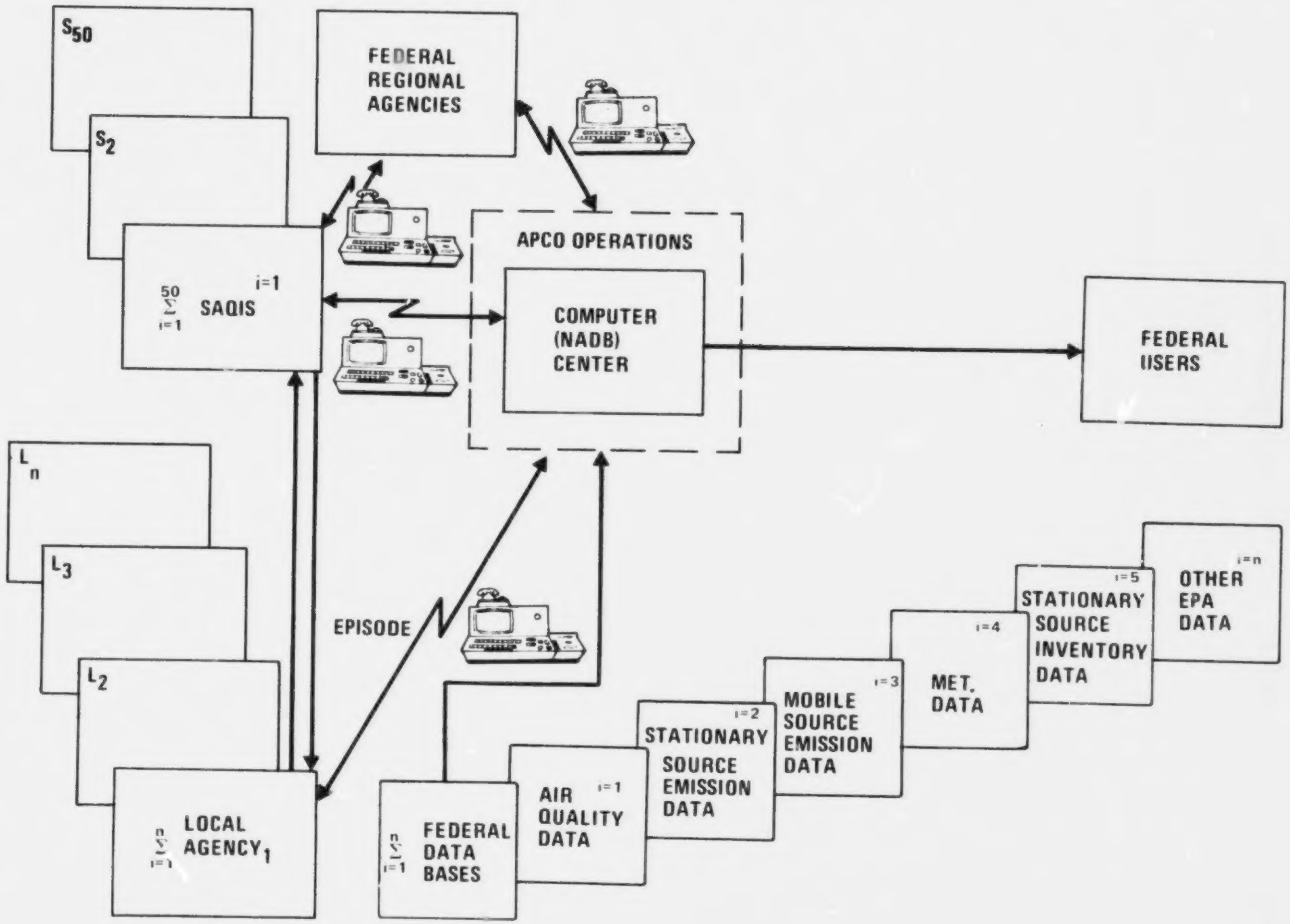
S_{50}
S_2
$\sum_{i=1}^{50}$ SAQIS $i=1$
FEDERAL REGIONAL AGENCIES
APCO OPERATIONS
COMPUTER (NADB) CENTER
FEDERAL USERS
L_n
L_3
L_2
$\sum_{i=1}^{n}$ LOCAL AGENCY$_1$
EPISODE
$\sum_{i=1}^{n}$ FEDERAL DATA BASES
AIR QUALITY DATA $i=1$
STATIONARY SOURCE EMISSION DATA $i=2$
MOBILE SOURCE EMISSION DATA $i=3$
MET. DATA $i=4$
STATIONARY SOURCE INVENTORY DATA $i=5$
OTHER EPA DATA $i=n$

FIGURE 1 - NADIS OVERVIEW

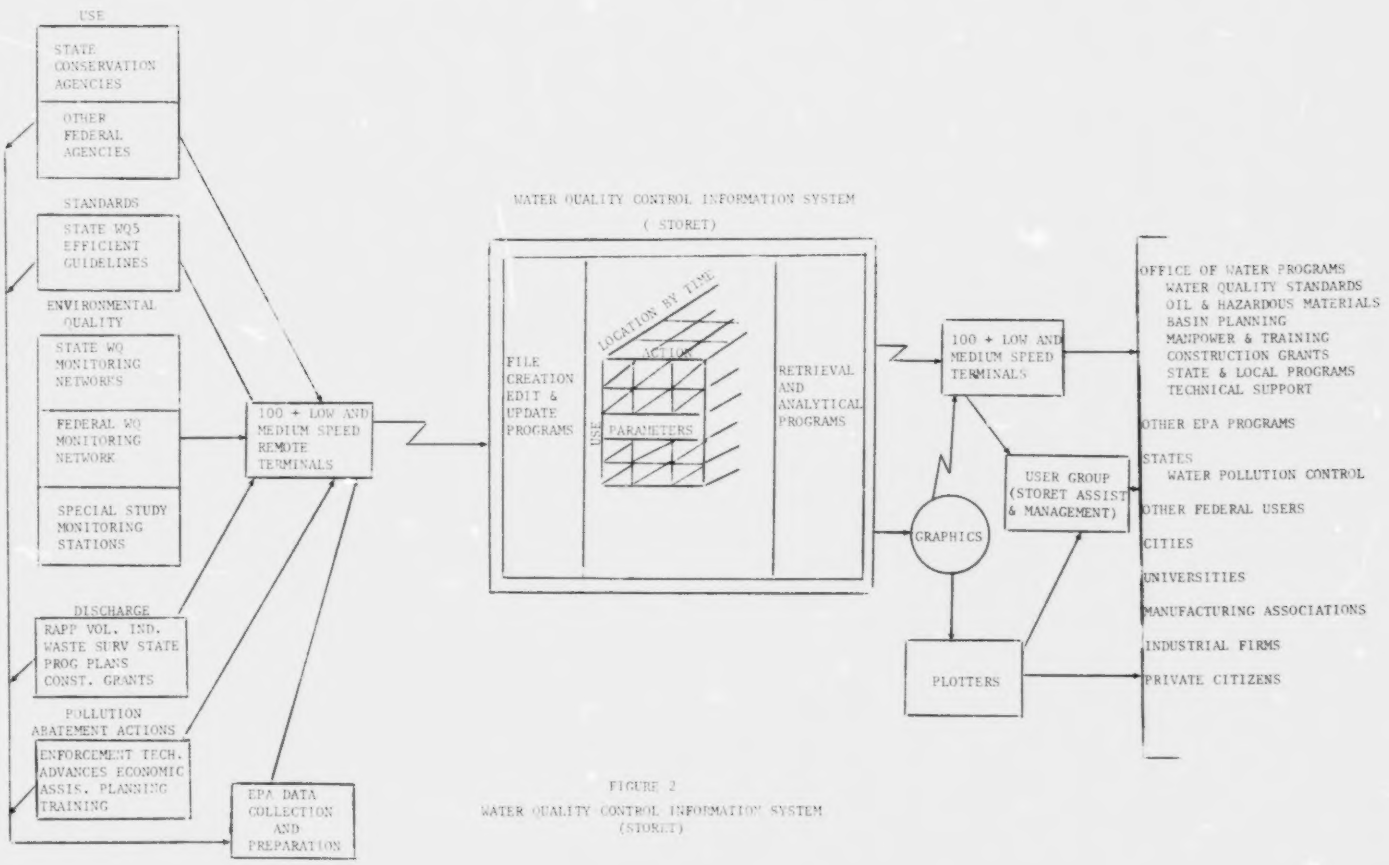
USE
STATE CONSERVATION AGENCIES
OTHER FEDERAL AGENCIES
STANDARDS
STATE WQS EFFICIENT GUIDELINES
ENVIRONMENTAL QUALITY
STATE WQ MONITORING NETWORKS
FEDERAL WQ MONITORING NETWORK
SPECIAL STUDY MONITORING STATIONS
DISCHARGE
RAPP VOL. IND. WASTE SURV STATE PROG PLANS CONST. GRANTS
POLLUTION ABATEMENT ACTIONS
ENFORCEMENT TECH. ADVANCES ECONOMIC ASSIS. PLANNING TRAINING
EPA DATA COLLECTION AND PREPARATION
100 + LOW AND MEDIUM SPEED REMOTE TERMINALS
WATER QUALITY CONTROL INFORMATION SYSTEM
(STORET)
FILE CREATION EDIT & UPDATE PROGRAMS
LOCATION BY TIME
ACTION
USE
PARAMETERS
RETRIEVAL AND ANALYTICAL PROGRAMS
100 + LOW AND MEDIUM SPEED TERMINALS
GRAPHICS
PLOTTERS
USER GROUP (STORET ASSIST & MANAGEMENT)
OFFICE OF WATER PROGRAMS
WATER QUALITY STANDARDS
OIL & HAZARDOUS MATERIALS
BASIN PLANNING
MANPOWER & TRAINING
CONSTRUCTION GRANTS
STATE & LOCAL PROGRAMS
TECHNICAL SUPPORT
OTHER EPA PROGRAMS
STATES
WATER POLLUTION CONTROL
OTHER FEDERAL USERS
CITIES
UNIVERSITIES
MANUFACTURING ASSOCIATIONS
INDUSTRIAL FIRMS
PRIVATE CITIZENS

FIGURE 2
WATER QUALITY CONTROL INFORMATION SYSTEM
(STORET)

earmarked for this monitoring category. This amounts to less than 5% of the resources expended on monitoring. Typical quality control expenditures in industry are in the order of 15 to 20%.

To support the air quality monitoring activity, a separate program element has been in operation to evaluate instrumentation for use in EPA's reference methods. Also, work has been started to develop a nationwide calibration/quality control program.

Standard methods for monitoring/analysis of pollutants in water have been in existence for a long time. Current efforts are to develop quality control procedures and to continue testing methodologies for routine application. A nationwide quality control program has not been established to support water monitoring activities.

In the case of radiation and pesticide monitoring activities, quality control and methods evaluation programs are currently being operated. A formalized system of interlaboratory quality control including centralized purchasing of standard materials is present for pesticide monitoring. The Office of Radiation Programs provides analytical quality control service to State agencies and utilities.

Technique Development

In FY72, 11.4 million dollars and 226 man years of effort are identified as the resources being spent for developing monitoring instrumentation and methodologies. This includes the development of instrumentation for environmental monitoring as well as the development of test procedures and equipment for measuring emissions and effluents.

MONITORING STRATEGY

The effective conduct of a national pollution control program requires that reliable information on environmental quality and pollution sources be collected, analyzed, and evaluated in a timely and efficient manner. This need has become more pressing with the establishment of environmental standards and the development of plans for their implementation and enforcement.

In order to meet EPA's data needs in a timely and efficient manner, existing fragmented monitoring activities must be effectively coordinated to achieve a totally integrated system. Specific needs within such an integrated monitoring system are:

1. A strong central standardization and quality control program.

2. A routine monitoring program with guidance provided from a single Headquarters element and operated by the Regions.

3. A central capability within the Agency to provide specialized monitoring and laboratory assistance.

4. An integrated information system easily accessible to Federal, State, and local agencies.

5. A mechanism for identifying methodology and instrumentation research needs and assuring a timely response to those needs.

6. Active interagency and international coordination programs.

It is proposed that a strong centrally managed methods standardization and quality control program be implemented. Properly operated, it would assure a legally valid nationwide data base. Under the approach proposed, program control would reside within a single Headquarters program. All standard and/or reference methods would be developed at the National Environmental Research Centers (NERCs) and the Western Environmental Research Laboratory (WERL). The quality control program would be developed and implemented by the NERCs and WERL working through the Regions. All EPA organizational elements involved in environmental and pollution source data acquisition would be required to adhere to standard methods established within this program. State and local environmental control programs and other cooperating agencies involved in gathering and exchanging data with EPA would also be expected to adopt these same methods to the extent possible.

Environmental monitoring can be accomplished in two ways. One is through the operation of a vast network of strategically located long-term stations. A second approach makes use of repeated short-term surveys, each generally providing limited spatial and temporal coverage. Data needs can be met most efficiently by use of both approaches. A nationwide environmental network that uses a minimal number of long-term stations can be used to identify baseline environmental quality, general areas of adverse trends in environmental conditions and violations in environmental standards. Where problems are found, short-term intensive surveys can then be conducted to fully define the extent of the problem, plus all factors contributing to the problem.

The long-term routine type of monitoring activity meets many of the data needs of many EPA organizational units. Short-term intensive surveys are generally conducted to meet the additional data needs of each specific organizational unit (e.g., Office of Enforcement, Division of Oil and Hazardous Materials or Office of Research). Consolidation of the various routine types of monitoring activities serving the common needs of several EPA organizational units would serve to prevent duplication and permit greater economies of scale to be achieved in day-to-day operations.

Accordingly, it is proposed that all routine environmental monitoring activities be placed under the control and guidance of a single Headquarters program. Network operation would be carried out by the EPA Regional Offices and State and local agencies working in close coordination. State and local agencies would be expected to monitor for common pollutants, particularly in intrastate situations. EPA Regional Offices would be expected to assume primary responsibility for monitoring in interstate situations and in the evaluation of unusual or newly identified pollutants. The Regional Offices would also be expected to carry out monitoring activities of the States where States fail to meet their responsibilities. This consolidation would facilitate the use of common methods and common facilities in the evaluation of contaminants in air, water, soils, and other environmental media.

It is proposed that non-routine or special purpose monitoring activities be required to follow guidelines developed for the routine monitoring activities, where such guidelines are applicable. This would serve to ensure the comparability and compatibility of all data generated by EPA and cooperating agencies. As long as adherence to applicable guidelines were assured, central control of these special purpose monitoring activities would offer little advantage over the presently decentralized mode of operation. The ability of a given organizational unit to quickly and fully respond to emergency situations would thus not be hampered.

There is a need for a fully equipped laboratory at each NERC staffed with highly qualified personnel to provide support and expertise to the Regions and State and local programs in the evaluation of new and unusual pollutants. This would permit full use by EPA of a minimum number of expensive laboratory instruments. Without such central facilities, each Region would be required to equip its monitoring support laboratory with expensive instrumentation that would be only partially utilized. These facilities and personnel would also be used to operate special monitoring networks required to provide information necessary for development of criteria for environmental and emission/effluent standards, establishment of baseline information on esoteric pollutants, support of research studies, and the operation of an early warning system.

It is also proposed that an integrated technical information system be established within EPA. This system, controlled by a single Headquarters program and operated by one or more NERCs working

through the Regions, would develop linkages among existing information systems (e.g., STORET and NADIS) and provide for complete compatibility of all data stored in the integrated system. The integrated system would also provide for easy accessibility to the stored data by Federal, State, and local agencies. Comprehensive nationwide analysis of data on the total environment (i.e., air, water, soils, et.al.) would be carried out on a routine basis. Under this integrated system, an early warning program would also be operated for identification of incipient environmental problems.
General guidance would be provided to various organizational units utilizing the integrated information system as required to facilitate the storage of all data in a compatible format.

The proposed strategy also calls for the establishment of a centralized program with responsibility for identifying to the Office of Research instrumentation and analytical methodology needs and target dates for meeting these needs. This program would also have responsibility for coordinating with the Office of Research in the testing and evaluation of new monitoring instruments and methods prior to their acceptance for routine use.

It is also proposed that a central authority be given responsibility for carrying out a fully effective interagency and international coordination program. This activity would include participation with other nations in the planning of international monitoring programs, participation in existing committees and where required the establishment of new interagency monitoring coordinating committees, and providing technical guidance over the EPA portion of global monitoring activities.

The strategy outlined can be accomplished with the establishment of five program elements and the assignment of responsibilities for these elements to a single office. These program elements, given below, encompass all monitoring activities where central guidance is essential to most effective execution.

Methodology and Instrumentation Standardization and Quality Control

Evaluate and modify existing methods and assess new methods for the qualitative and quantitative measurement of pollutants in all media and sources. Develop procedures for the calibration of instrumentation used in the measurement of pollutants. Coordinate throughout EPA the selection of standard methods to be used in all EPA laboratories and in all field operations for the measurement of environmental pollutants. Develop and manage an EPA-wide quality control program for assessing the validity of environmental data.

Environmental Monitoring Operations

With centralized direction and guidance provided by Headquarters, implement and operate integrated environmental monitoring programs through the Regions. Centrally operate special networks, conduct special purpose studies, and operate central laboratories providing special analytical and technical expertise to national, regional, state, and local monitoring activities.

Information Systems and Data Analysis

Develop and maintain compatibility and inter-connections between and among existing EPA environmental information storage and analysis systems. Manage all EPA environmental data systems, providing for and assuring that comprehensive analyses of environmental data on a nationwide basis be routinely performed. Operate an early warning program to identify incipient environmental problems.

Monitoring Techniques, Instrument and Analytical Methodology Development

Identify to the Office of Research, near-term and long-term environmental monitoring instrumentation and analytical methodology needs, including requirements for both *in situ* and remote monitoring instruments and techniques.

Interagency and International Coordination

> Establish and maintain coordination with other interagency and international monitoring activities by participating in permanent coordinating committees which maintain formal channels of communication, maintaining liaison with monitoring activities of international organizations, and coordinating monitoring support during emergencies.

Existing program elements or portions thereof falling under each of these five proposed program elements and recommended for centralized control are listed in Table 4. Resources programmed for the monitoring aspects of each of the program elements in FY 1972 and 1973 are also given.

Other on-going monitoring activities within EPA, of a special purpose nature, are listed by categories in Table 5. These include quick response studies of pollution episodes, pollution source studies, and monitoring associated with many research projects. Centralized control of these activities would offer little advantage over the presently decentralized mode of operation provided that effective coordination is maintained between these and the centrally controlled general purpose monitoring activities. These special purpose monitoring activities should, of course, be required to utilize the Agency's standardized methods, participate in the Agency-wide quality control program, and enter all data concerning environmental quality and pollution sources into the integrated information system. To assure that the standardization is being effected, these programs should be reviewed on a regular basis by a central monitoring authority.

TABLE 4 - EPA PROGRAM ELEMENTS REQUIRING CENTRALIZED PROGRAM CONTROL

PROPOSED PROGRAM ELEMENT: INFORMATION SYSTEMS AND DATA ANALYSIS

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
Office of Air Programs	NADIS (110502)	Operation of a national information system for storage of all aerometric data. Hook-ups with Regions and States	32.0[a] (32.0)[b]	700.0 (700.0)	32.0 (32.0)	700.0 (700.0)
Office of Water Programs	STORET (310504)	Covers the operation of STORET which serves as the repository of all water data	71.0 (71.0)	1536.0 (1536.0)	71.0 (71.0)	1536.0 (1536.0)
Office of Radiation	National Environmental Radiation Monitoring Program (610501)	Provide a national data bank of information on environmental radiation levels from all sources	12.8 (12.8)	240.0 (240.0)	14.1 (14.1)	240.0 (240.0)
		Totals:	115.8 (115.8)	2476.0 (2476.0)	117.1 (117.1)	2476.0 (2476.0)

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a) The top numbers indicate total original program element resources
b) Numbers in parentheses indicate portions of the original program element resources which are related to monitoring
c) Certain of the original program elements have been subdivided and placed in two or more new monitoring program elements

PROPOSED PROGRAM ELEMENT: METHODOLOGY AND INSTRUMENTATION STANDARDIZATION AND QUALITY CONTROL

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
Office of Research and Monitoring	Standardization of Instrumentation and Analytical Methods (110402)	Evaluate instrumentation and recommend its use as EPA standard or reference method. Develop calibration standards	13.8 (13.8)	1428.5 (1428.5)	12.0 (12.0)	1236.3 (1236.3)
	Physical and Chemical Identification of Pollutants (310401)	Testing methodology for routine use and quality control procedure development	2.0 (2.0)	50.0 (50.0)	2.0 (2.0)	50.0 (50.0)
	Quality Control and Methods Evaluation (510301)	Evaluation of new instruments for pesticide monitoring and formalized system of interlaboratory quality control includes centralized purchasing of standard materials	8.0 (8.0)	142.6 (142.6)	8.0 (8.0)	142.6 (142.6)
Office of Air Programs	Sampling Network Operations (110501)	Operation of a skeleton calibration/quality control program	5.0 (5.0)	130.0 (130.0)	5.0 (5.0)	130.0 (130.0)
Office of Radiation	National Environmental Radiation Monitoring Program (610501)	Provide analytical quality control service to State agencies and utilities	6.0 (6.0)	112.0 (112.0)	6.6 (6.6)	112.0 (112.0)
		Totals:	34.8 (34.8)	1863.1 (1863.1)	33.6 (33.6)	1670.9 (1670.9)

PROPOSED PROGRAM ELEMENT: ENVIRONMENTAL MONITORING OPERATIONS

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
Office of Research and Monitoring	Regional Air Pollution Study (110103)	Operation of fixed and mobile land and air monitoring stations to provide data to support atmospheric research and model development	Being developed		NA	1994.0 (1574.0)
	Fuels and Fuel Additive Registration (110102)[c]	Routinely collect/analyze fuels for various trace elements and compounds	3.0 (3.0)	240.0 (240.0)	1.7 (1.7)	235.0 (235.0)
	AEC Off-Site Radiological Safety Program (610502)[+]	Radiation monitoring program to document external exposure of people in vicinity of nuclear testing facilities	110.0 (110.0)	1942.0 (1942.0)	110.0 (110.0)	1942.0 (1942.0)
Office of Air Programs	Sampling Network Operations (110501)	Operates nationwide networks to determine environmental quality, supports standard setting, evaluates trends	94.0 (94.0)	2005.0 (2005.0)	94.0 (94.0)	2005.0 (2005.0)
	Emergency Episode Control (121501)	Provide field teams for monitoring during episodes	12.0 (3.0)	870.0 (150.0)	12.0 (4.0)	870.0 (200.0)
Office of Water Programs	Water Quality Surveillance Network (310502)	Operates 900 Federally-funded stations (60 continuous monitors)	85.0 (85.0)	1840.0 (1840.0)	85.0 (85.0)	1840.0 (1840.0)
Office of Pesticides	Residue Profiles (510302)	National Soils Monitoring Program, includes air and water sampling. A total of 3000 sites nationwide.	47.0 (47.0)	1302.5 (1302.5)	47.0 (47.0)	1318.5 (1318.5)

[+] Funding supplied by AEC and programmed through WERL

ENVIRONMENTAL MONITORING OPERATIONS (Continued)

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
Office of Radiation	National Environmental Radiation Monitoring (610501)	Routine operation of pasteurized milk network, total diet monitoring network, bone network, RAN, Water Analysis Project, Tritium Surveillance, PAHO Cooperative Network	31.3 (31.3/ 7.0)*	584.7 (584.7/ 140.3)*	34.3 (34.3/ 6.0)*	587.7 (587.7/ 110.0)*
		Totals:	382.0 (373.3)	8784.2 (8064.2)	384.0 (376.0)	10,792.2 (9,702.2)

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* These numbers indicate Headquarters and WERL and EERL support and direction for the program element

TABLE 5 - EPA PROGRAM ELEMENTS REQUIRING CENTRALIZED TECHNICAL GUIDANCE

PROPOSED PROGRAM ELEMENT: INFORMATION SYSTEMS AND DATA ANALYSIS

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
Office of Research and Monitoring	Fuels and Fuel Additive Registration (110102)	Data collection by questionnaire, maintenance of information on amounts of fuels and fuel additives used nationally	7.0 (7.0)	200.0 (200.0)	3.0 (3.0)	100.0 (100.0)
Office of Air Programs	Air Quality Procedures Development (130202)	Compilation of all existing source inventory data onto a computer for rapid retrieval--National Emission Data System	52.0 (8.0)	1915.0 (300.0)	52.0 (4.0)	1915.0 (50.0)
Office of Water Programs	Systems Monitoring (329400)	Development of a current inventory of municipal water treatment facility and means for maintaining the inventory continuously to date	11.0 (11.0)	184.0 (184.0)	11.0 (11.0)	184.0 (184.0)
	Water Supply Systems, Enforcement (329500)	Classification of all municipal water supply systems	16.0 (0.8)	280.0 (14.0)	16.0 (0.8)	280.0 (14.0)
	Implement Schedule Monitoring and Reporting (310501)	Provides for computerized storage in STORET of implementation schedules	33.0 (33.0)	483.0 (483.0)	33.0 (33.0)	483.0 (483.0)
	Water Use and Standards Information (310503)	Computerization of water use classification to allow comparison of quality data with standards	16.0 (16.0)	236.0 (236.0)	16.0 (16.0)	236.0 (236.0)
Office of Solid Wastes	National Solid Waste Data Network (410501)	Establish, operate a system which collects, analyzes, and disseminates operations data from 30 SMSA base stations, 40 State base stations, and 300 county base stations	6.0 (6.0)	405.0 (405.0)	6.0 (6.0)	405.0 (405.0)
	Inventory (425301)	Complete a baseline inventory of solid waste disposal practices and conditions at over 80,000 Federal facilities	18.0 (18.0)	241.7 (241.7)	18.0 (18.0)	241.7 (241.7)

INFORMATION SYSTEMS AND DATA ANALYSIS (Continued)

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
Office of Pesticides	Market Surveillance (521401)	Monitoring of temporary permits of use of pesticides and stop sale monitoring	85.0 (85.0)	1121.2 (1121.2)	95.0 (95.0)	1253.2 (1253.2)
	Monitoring Accidents and Other Incidents (521B04)	A reporting system to gather and store information on incidents involving pesticides	17.0 (17.0)	219.6 (219.6)	27.0 (27.0)	401.6 (401.6)
Office of Radiation	Environmental Standards Development (610101)	Ionizing Radiation Service Inventory--inventory all radiation sources in U.S.	16.0 (12.0)	622.4 (430.0)	19.0 (10.0)	922.6 (375.0)
		Totals:	277.0 (213.8)	5907.9 (3834.5)	296.0 (223.8)	6422.1 (3743.5)

PROPOSED PROGRAM ELEMENT: ENVIRONMENTAL MONITORING NETWORKS

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
Office of Research and Monitoring	Community Health and Environmental Surveillance Studies (110201)	Operate routine sampling/monitoring networks in ten cities to support epidemiological studies	43.0 (11.0)	1955.0 (488.7)	70.0 (17.5)	2666.0 (667.0)
	Meteorological Research (110301)	Operate aircraft monitoring effort to measure radiation levels in U.S. Measure effect of air pollution on solar radiation	NOAA	3314.0 (340.0)	NOAA	2806.0 (293.0)
	Fate of Pollutants in Surface Waters (310301)	Measure pollutants to support model development	17.0 (1.0)	900.0 (90.0)	14.0 (1.0)	950.0 (90.0)
	Fate of Pollutants in Ground Waters (310302)	Measure pollutants to determine scope and nature of ground water pollution	10.0 (1.0)	400.0 (40.0)	9.0 (1.0)	440.0 (40.0)
	Fate of Pollutants in Marine Waters (310303)	Characterize water circulation pattern at disposal sites	17.0 (1.7)	1529.0 (153.0)	16.5 (1.7)	1649.0 (153.0)
	Fate of Pollutants in Large Lakes (310304)	Assess changes and quality and ecological changes in the Great Lakes	8.0 (1.0)	1050.0 (160.0)	7.5 (1.0)	1125.0 (160.0)
	Eutrophication and Lake Restoration (328201)	Sample/monitor study waters to gather data for predicting impact of nutrient sources of eutrophication	24.0 (2.4)	2233.0 (223.0)	25.0 (2.5)	2600.0 (250.0)
	Cold Climate Research (328202)	Sample/monitor cold climate water quality and evaluate water usage at various pollutant levels	14.0 (2.8)	1047.3 (210.0)	14.0 (2.8)	1220.0 (210.0)

ENVIRONMENTAL MONITORING NETWORKS (Continued)

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972 MY	FY 1972 $1000's	FY 1973 MY	FY 1973 $1000's
	Environmental Phenomena (410300)	Establish cause, sources, fate, transport of pollutants from solid waste management practices	To be started in FY74			
	Radiation Pathway Studies (610301)	Investigate through field and laboratory research... movement and fate of radionuclides in water, soil, and air to assess human exposure	19.5 (3.9)	421.6 (84.3)	19.5 (3.9)	570.0 (114.0)
Office of Noise	Environmental Evaluation and Appraisal (230201)	To be developed	---	---	---	---
	Noise Surveillance (21050A)	To be developed	---	---	---	---
Office of Water Programs	Spill Prevention and Response (326301)	Evaluate compliance with regulation for controlling and cleaning up oil and hazardous pollutant spills by monitoring spill incidents	80.0 (4.0)	1600.0 (80.0)	80.0 (4.0)	1600.0 (80.0)
	Spill Monitoring (326400)	Continuous monitoring at spill sites until corrected	25.0 (25.0)	433.0 (433.0)	25.0 (25.0)	433.0 (433.0)
	Major Technical Assistance (330201)	Technical assistance to EPA and State and local agencies	80.0 (4.0)	2000.0 (100.0)	80.0 (4.0)	2000.0 (100.0)
	Basic Technical Support (330202)	Assistance to EPA	100.0 (10.0)	2230.0 (223.0)	100.0 (10.0)	2230.0 (223.0)
	Estuarine and Oceanographic Studies (330203)	Develop national data base of pollution in estuarine, coast, ocean	1.0 (0.5)	750.0 (375.0)	1.0 (0.5)	750.0 (375.0)

ENVIRONMENTAL MONITORING NETWORKS (Continued)

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
	Major Technical Support Water Hygiene (330205)	Provide technical assistance including laboratory support	8.0 (0.8)	150.0 (15.0)	8.0 (0.8)	150.0 (15.0)
	Basic Technical Support Water Hygiene (330206)	Technical assistance	20.0 (0.6)	465.0 (14.0)	20.0 (0.6)	465.0 (14.0)
Office of Enforcement	Agricultural Sources - Field Investigations (323502)	Provide scientific data	---	---	---	---
	Agricultural Sources - Enforcement Action (323503)	Conduct on-site studies	---	---	---	---
	Multiple Sources - Enforcement (328501)	Extensive on-site studies	375.0 (75 0)	9150.0 (1830.0)	725.0 (145.0)	12,250.0 (2,450.0)
Office of Pesticides	Pesticide Exposure Health Effects (510501)	Nationwide monitoring of food, water, air, and soil to support the health study	16.0 (0.6)	3592.0 (144.0)	21.0 (0.8)	4,193.0 (168.0)
		Totals:	857.5 (145.3)	33,219.6 (5,003.0)	1245.5 (208.6)	38,097.0 (5,835.0)

PROPOSED PROGRAM ELEMENT: MONITORING TECHNIQUES, INSTRUMENT AND ANALYTICAL METHODOLOGY DEVELOPMENT--Development Oriented

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972 MY	FY 1972 $1000's	FY 1973 MY	FY 1973 $1000's
Office of Research and Monitoring	Instrumentation and Analytical Methods Development (110401)	Modify already developed analytical procedures and basic instrumentation for measuring and analyzing those pollutants for which standards are being issued	66.0 (65.0)	5447.0 (5232.0)	52.0 (51.0)	4109.0 (3894.0)
	Physical Chemical Identification of Pollutants (310401)	Develop and evaluate for sampling/monitoring network use instrumentation and methodology for physical-chemical water measurements	50.0 (48.0)	1871.2 (1821.2)	50.0 (48.0)	1871.2 (1821.2)
	Biological Identification of Pollutants (310402)	Develop rapid techniques for measuring indicator bacteria and evaluating viruses in water supplies and waste waters	28.0 (28.0)	1020.0 (1020.0)	28.0 (28.0)	1020.0 (1020.0)
	Sources of Pollutants (310403)	Develop instrumentation capable of sampling/monitoring all plant or other source effluents	9.0 (9.0)	480.0 (480.0)	9.0 (9.0)	480.0 (480.0)
	Hazardous Material Spills (326101)	Develop instrumentation for detecting, sampling, and monitoring hazardous spills in waterways	9.0 (0.2)	1757.3 (176.0)	9.0 (0.2)	1750.0 (176.0)
	Oil Spills (326102)	Develop instrumentation for detecting, sampling, and monitoring oil spills in waterways	15.0 (1.0)	3937.4 (394.0)	15.0 (1.0)	3937.4 (394.0)
	Monitoring and Analytical Studies (410400)	Develop instrumentation and methods for sampling/monitoring pollutants in air, land, water resulting from solid waste disposal	To be initiated in 1974			
	Product Identification (510402)	Develop instrumentation and methods for detecting, sampling, and monitoring pesticides in the environment	9.0 (9.0)	181.0 (181.0)	9.0 (9.0)	131.0 (181.0)

MONITORING TECHNIQUES, INSTRUMENT AND ANALYTICAL METHODOLOGY DEVELOPMENT--Development Oriented (Continued)

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
	Radiochemical Methods and Measurements (610401)	Develop instrumentation and methods for sampling/monitoring air, water, soil vegetation, and biological material for radiation levels	14.0 (7.0)	250.6 (125.3)	14.0 (7.0)	285.0 (142.5)
	Electromagnetic Radiation Methods and Measurements (610402)	Develop instrumentation and methods for monitoring specific electromagnetic spectrum bands in the environment	11.0 (0.6)	308.6 (13.4)	12.0 (1.8)	301.5 (45.2)
Office of Water Programs	Development and Automation (310404)	New and standard methods adoption to automated methods for evaluating water quality in water treatment plants and distribution systems	9.0 (9.0)	363.0 (363.0)	9.0 (9.0)	363.0 (363.0)
	Biological Identification of Pollutants (310405)	Develop and test methods for evaluating virological characteristics of raw and furnished H_2O used in municipal supplies	24.0 (24.0)	474.0 (474.0)	24.0 (24.0)	474.0 (474.0)
	Regulation, Toxicity Assay Systems Development (329300)	Develop assay systems for measuring toxicity of inorganic and organic contams. in H_2O supplies, determine toxicity of various agents, maintain data storage-retrieval on toxicity data	30.0 (3.0)	920.0 (92.0)	30.0 (3.0)	920.0 (92.0)
Office of Noise	Monitoring and Analytical Methods (21040A)	To be developed	---	---	---	---
	Measurement of Noise (210401)	To be developed	---	---	---	---

MONITORING TECHNIQUES, INSTRUMENT AND ANALYTICAL METHODOLOGY DEVELOPMENT--Development Oriented (Continued)

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
Office of Solid Waste	Processing Methods (421105)	Develop alternative operationally proven processing techniques which prepare municipal solid waste for reuse, recovery, or ultimate disposal; develop equipment for sampling/monitoring incinerators	4.0 (0.1)	743.4 (15.0)	4.0 (0.1)	743.4 (15.0)
		Totals:	278.0 (203.9)	17,753.5 (10,388.9)	265.0 (191.1)	16,435.5 (9,925.9)

PROPOSED PROGRAM ELEMENT: MONITORING TECHNIQUES, INSTRUMENTS AND ANALYTICAL METHODOLOGY DEVELOPMENT--Operations Oriented

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972 MY	FY 1972 $1000's	FY 1973 MY	FY 1973 $1000's
Office of Research and Monitoring	Fuels and Fuel Additive Registration (110102)	Provide standardized test procedures needed for emission characterization	7.0 (7.0)	255.0 (255.0)	3.0 (3.0)	277.0 (277.0)
	Water Resource Data (330A01)	Develop new methods and management approaches for water quality data acquisition, transmission, processing and dissemination	3.0 (0.2)	896.0 (90.0)	3.0 (0.3)	1313.0 (100.0)
Office of Air Programs	Sampling Network Operations (110501)	Technique development and modifications for field and routine application, both environmental and pollution source sample analysis	7.0 (7.0)	185.0 (185.0)	7.0 (7.0)	185.0 (185.0)
	Mobile Source Regulation Development (122301)	Develop test methods for measuring mobile source emissions employing already developed instrumentation	70.0 (7.5)	3816.0 (500.0)	70.0 (7.5)	3816.0 (500.0)
		Totals:	87.0 (21.7)	5151.0 (1030.0)	83.0 (17.8)	5591.0 (1775.0)

POLLUTION SOURCE MONITORING

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
Office of Air Programs	New Source Performance Standards (121301)	Field sampling of emissions	38.0 (8.0)	1955.0 (985.0)	38.0 (7.0)	1955.0 (1070.0)
	Industry Studies (121302)	Field sampling of emissions	30.0 (3.0)	2051.0 (375.0)	30.0 (10.0)	2051.0 (1030.0)
	Hazardous Pollutants (121303)	Field sampling of emissions	12.0 (2.0)	592.0 (190.0)	12.0 (4.0)	592.0 (360.0)
	Sampling Network Operations (110501)	Routine laboratory analysis of source samples	11.0 (11.0)	300.0 (300.0)	11.0 (11.0)	300.0 (300.0)
	Mobile Source Regulations Development (122301)	Measure exhaust from autos and aircraft to support new standards	70.0 (7.5)	3816.0 (700.0)	70.0 (7.5)	3816.0 (700.0)
	In-Use Mobile Source Enforcement (122401)	Monitor in specific areas to obtain in-use LDV emission values and establish State inspection program for in-use LDV standards compliance	11.0 (11.0)	2400.0 (2400.0)	11.0 (11.0)	3500.0 (3500.0)
	New Mobile Source Enforcement (122501)	Spot checking of manufacturers tests on prototypes	68.0 (10.0)	1250.0 (150.0)	102.0 (10.0)	2225.0 (150.0)
	Unknown	Providing a central laboratory emission testing capability	34.0 (27.2)	1900.0 (1520.0)	34.0 (27.2)	1900.0 (1520.0)
Office of Water Programs	Municipal Sources of Pollution (320400)	Monitoring of effluents from municipal treatment plants	28.0 (28.0)	458.0 (458.0)	28.0 (28.0)	458.0 (458.0)

POLLUTION SOURCE MONITORING (Continued)

Organization	Program Element	Description of Monitoring Portion of Program Element	FY 1972		FY 1973	
			MY	$1000's	MY	$1000's
	Industrial Sources of Pollution (321400)	Monitoring of effluents from industrial sources	57.0 (57.0)	910.0 (910.0)	57.0 (57.0)	910.0 (910.0)
	Agricultural Sources of Pollution (323400)	Monitoring of effluent	9.0 (9.0)	158.0 (158.0)	9.0 (9.0)	158.0 (158.0)
	Mining Sources of Pollution (324400)	Monitoring of effluent	8.0 (8.0)	140.0 (140.0)	8.0 (8.0)	140.0 (140.0)
	Federal Sources of Pollution (325400)	Monitoring of effluent	4.0 (4.0)	53.0 (53.0)	4.0 (4.0)	53.0 (53.0)
Office of Pesticides	Sample Analysis (521402)	Product samples are analyzed and information is reported	130.0 (130.0)	1910.5 (1910.5)	145.0 (145.0)	2310.5 (2310.5)
Office of Radiation	Nuclear Facilities Inspections (621401)	Monitoring of effluent from nuclear facilities	14.0 (14.0)	202.7 (202.7)	14.0 (14.0)	203.7 (203.7)
		Totals:	524.0 (329.7)	18,126.2 (10,452.2)	539.0 (352.7)	20,572.2 (12,863.2)

APPENDIX 1

ATTACHMENTS TO THE STRATEGY DOCUMENT

"AN INTEGRATED NATIONWIDE
MONITORING PROGRAM
FOR SHORT-TERM
IMPLEMENTATION"

Attachment
1. Detailed Monitoring Needs by Major Categories
2. Statutory Authority for Monitoring
3. EPA Organizational Responsibilities for Monitoring Activities

Appendix 1

ATTACHMENT #1

DETAILED MONITORING NEEDS BY MAJOR CATEGORIES

1. Surveillance for Enforcement Needs

   a. Legal Evidence of Violations

      Monitoring of emission, effluents and pollutant concentration to provide evidence of violations and the extent of the violation.

   b. Detection of Violations

      Initial detection of potential violations for subsequent investigation as above.

   c. Expert Testimony

      Providing information from expert witnesses, using the monitoring system capabilities and scientific information, for legal testimony.

   d. Utilization of Voluntary Information

      Effective use of information received on a voluntary basis from industry such as provided by the permit program of the 1899 Refuse Act.

2. Administrative Monitoring Needs

   a. Environmental Trends

      Determination of long term trends in the environment such as changes in the albedo, and upper atmosphere. The long term impact of identified changes will have major impact in program decisions that will affect the environment.

b. Environmental Indices

Aggregated measurements for measuring general changes to the environment, for providing measures of program goal attainment, and for dissemination to the public sector.

c. Decision Making Information

Measures of conditions of the environment that provide inputs to selection of program alternatives for control and abatement.

3. Ambient Environment Needs

a. Background, Ambient and Episode Monitoring Programs

Measurement of environmental parameters and pollutants to determine background mode, ambient conditions in a dynamic environment, and emergency reporting during episodic environmental conditions.

b. Early Warning Program

A program to determine incipient adverse environmental conditions prior to their becoming major problems. This is a network that overlays the background, ambient and episode network although there may be some interaction. Both short term warning and prediction of problems and early detection of long term trends are required.

4. Research and Scientific Information

Information gained by scientific research is used for:

a. Setting standards - determination of health, biological, economic, and other environmental effects for specific pollutants and ecological systems.

b. Environmental Impact Assessment - investigating the alternatives available for solving existing or potential environmental problems on a specific problem basis.

c. Source - Receptor Relationships - determining the emission or effluent source relationship of specific pollutants to resultant environmental concentrations. Includes modelling of the processes involved. The interaction of pollutants, their decay and dispersion and dilution are included.

d. New Threats - Early identification and quantification of new or newly recognized pollutants.

e. Coordination of Scientific Information - A compatible system is required to assure effective dissemination, exchange, and utilization of available research information. The substance of the information, not the program description is intended here. The description of programs can be better handled by technical information centers or a clearing house such as recommended by the SEQUIP study.

APPENDIX I

ATTACHMENT 2

Staturory Authority for Monitoring

MONITORING-RELATED ACTIVITIES CONDUCTED BY EPA UNDER PRESENT LAWS

I. WATER POLLUTION: Federal Water Pollution Control Act, Refuse Act Permit Program

The above, comprise the enabling statues for EPA's water pollution control activities, and we have no monitoring responsibilities under the Permit Program.

Federal Water Pollution Control Act (33 U.S.C. 1151, et seq)

Sec. No.	Activity Authorized
3(a)	"Careful investigations" are required in the development of comprehensive plans for abatement of pollution in interstate waters; "joint investigations" with the States are also authorized.
5(a)	EPA shall conduct "research, investigations, experiments, demonstrations, and studies" of the causes, control, and prevention of water pollution.
5(e)	EPA shall establish "field laboratories and research facilities to conduct research, investigations, experiments, field demonstrations, and studies and training" pertaining to prevention and control of water pollution.
5(m)(1)	EPA shall conduct a comprehensive study of the effects of pollution on estuarine zones.
10(d)(2)	EPA may call an enforcement conference on the basis of "reports, surveys, or studies."
10(f)(2)	EPA may require reports under oath from alleged polluters in connection with a public hearing.
10(k)(1)	EPA may request (but not require) reports from alleged polluters at the request of a majority of the conferees at an enforcement conference.
13(g)(3)	EPA may inspect and copy records required to be kept by manufacturers of vessel sewage treatment facilities.
21(b)(4)	EPA can inspect a federally-licensed facility

Sec. No.	Activity Authorized
	before it is placed in operation, to ensure that applicable water quality standards will not be violated.
22(e)	EPA may inspect books and records pertaining to any grant under the FWPCA.

II. AIR POLLUTION: The Clean Air Act

The Clean Air Act is the only enabling statute for EPA's air pollution control activities, and your survey of it is thorough.

Clean Air Act (42 U.S.C. 1857 *et seq*)

Sec. No.	Activity Authorized
103(a)(1)	EPA shall conduct "research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, and control of air pollution."
103(a)(3)	EPA may cooperate with any air pollution control agency in investigation of a specific air pollution problem.
103(f)	In conducting research under the Clean Air Act, EPA shall give special emphasis to public health aspects, by epidemiological, clinical, and laboratory studies.
114	EPA may impose record-keeping and reporting requirements, install testing devices on private property, enter any emission source or place where records are kept, copy such records, and sample such emission for purposes of: i) developing or enforcing implementation plans under sections 110 (relating to ambient air quality standards), and 111(d) (relating to State-imposed emission standards for certain stationary sources) and performance standards under section 111 (relating to new stationary sources).

Sec. No.	Activity Authorized
	ii) developing or enforcing emission standards under section 112 (relating to hazardous substances); and
	iii) taking emergency action under section 303 (relating to abatement of air pollution causing or contributing to an imminent and substantial danger to public health).
115(b)(3)	EPA may call an enforcement conference on the basis of "reports, surveys, and studies."
115(j)(1)	EPA may require reports from polluters in connection with enforcement conferences, and may require such reports under oath if the conference so desires.
206(a)	EPA shall test autos, auto engines or auto emission control systems.
206(b)(1)	EPA may test vehicles, or require that they be tested by the manufacturer, to ensure compliance with emission standards.
206(c)	EPA has access to plants for testing and inspecting records pertaining to auto emission controls.
207(c)(1)	EPA may test privately-owned autos, with the owners' consent (see section 207(f)), if it first determines a substantial number of a given class of auto does not conform with auto emission standards.
208(a)	EPA may inspect and copy records required to be kept by auto manufacturers.
211(b)	EPA may require manufacturers to test fuel additives.
212(d)(3)(D)	EPA may, in conjunction with Low-Emission Vehicle Certification Board, test low-emission vehicles.
212(h)	EPA may, at the instance of the Board, test low-emission vehicles in Federal Government's fleet.

Sec. No.	Activity Authorized
311	EPA may have access to the pertinent records of any grant recipient under the Clean Air Act.

III. PESTICIDES: Federal Insecticide, Fungicide and Rodenticide Act

The Federal Insecticide, Fungicide and Rodenticide Act is the only pesticides law under which we operate and again, your survey of it is thorough.

Federal Insecticide, Fungicide and Rodenticide Act
(7 U.S.C. 135 *et seq*)

Sec. No.	Activity Authorized
5	EPA may inspect and copy records of any supplier or shipper of economic poisons, relating to quantities and types of economic poisons shipped or sold.
6(a)	EPA authorized to require submission of samples of any economic poison subject to the Act.
10	Upon notification by Treasury Department, EPA shall sample imported economic poisons.

IV. RADIATION: Public Health Service Act, Atomic Energy Act, President's Reorganization Plan No. 3

Sections of the Public Health Service Act which give us some monitoring authority and which you did not mention follow:

Public Health Service Act (42 U.S.C. 201 *et seq*)

Sec. No.	Activity Authorized
301	EPA shall conduct "research, investigations, experiments, demonstrations, and studies relating to the causes, diagnosis, treatment, control, and prevention of physical and mental impairments of man ...."

GRANTS FOR STATE HEALTH PLANNING SERVICES

314(a)(2)(G).. In order to be approved for purposes of this subsection, a State plan must provide that the State agency will make such reports, in such form and containing such information, as the Secretary may from time to time reasonably require, and will keep such records and afford such access thereto as the Secretary finds necessary to assure the correctness and verification of such reports;

(d)(2)(H).. provide that the State health authority or, with respect to mental health services, the State mental health authority, will make such reports, in such form and containing such information, as the Secretary may from time to time reasonably require, and will keep such records and afford such access thereto as the Secretary finds necessary to assure the correctness and verification of such reports;

The section of the Atomic Energy Act (42 U.S.C. 2021(h) the responsibility for which was transferred to us by Reorganization Plan No. 3 is given below:

2021(h)........ There is established a Federal Radiation Council, consisting of the Secretary of Health, Education, and Welfare, the Chairman of the Atomic Energy Commission, the Secretary of Defense, the Secretary of Commerce, the Secretary of Labor, or their designees, and such other members as shall be appointed by the President. The Council shall consult qualified scientists and experts in radiation matters, including the President of the National Committee on Radiation Protection and Measurement, and qualified experts in the field of biology and medicine and in the field of health physics. The Special Assistant to the President for Science and Technology, or his designee, is authorized to attend meetings, participate in the deliberations of, and to advise the Council. The Chairman of the Council shall be designated by the President from time to time, from among the members of the Council. The Council shall advise the President with respect to radiation matters, directly or indirectly affecting health, including guidance for all Federal agencies in the formulation of radiation standards and in the establishment and execution of programs of cooperation with States. The Council shall also perform such other functions as the President may assign to it by Executive Order.

Other AEC responsibilities transferred to us by Plan 3 do include monitoring related activities, but are not specifically described in any Federal statute. Attached (Appendices 1 and 2) are the pertinent sections of Reorganization Plan No. 3, and some explanatory remarks made by the Administrator before the Joint Committee on Atomic Energy.

V. NOISE POLLUTION: Clean Air Act

The section of the Clean Air Act which established the Office of Noise Abatement and Control is given below:

402(a)........ The Administrator shall establish within the Environmental Protection Agency an Office of Noise Abatement and Control, and shall carry out through such Office a full and complete investigation and study of noise and its effect on the public health and welfare in order to (1) identify and classify causes and sources of noise, and (2) determine--

(A) effects at various levels;
(B) projected growth of noise levels in urban areas through the year 2000;
(C) the psychological and physiological effect on humans;
(D) effects of sporadic extreme noise (such as jet noise near airports) as compared with constant noise;
(E) effect on wildlife and property (including values);
(F) effect of sonic booms on property (including values); and
(G) such other matters as may be of interest in the public welfare.

(b) In conducting such investigation, the Administrator shall hold public hearings, conduct research, experiments, demonstrations, and studies. The Administrator shall report the results of such investigation and study, together with his recommendations for legislation or other action, to the President and the Congress not later than one year after the date of enactment of this title.

VI SOLID WASTE: The Solid Waste Disposal Act (Public Law 89-272 89th Congress)

205(a)(1)..... The Secretary shall carry out an investigation and study to determine--

(1) means of recovering materials and energy from solid waste, recommended uses of such materials and energy for national or international welfare, including identification of potential markets for such recovered resources, and the impact of distribution of such resources on existing markets;
(2) changes in current product characteristics and production and packaging practices which would reduce the amount of solid waste;

(3) methods of collection, separation, and containerization which will encourage efficient utilization of facilities and contribute to more effective programs of reduction, reuse, or disposal of wates;

(4) the use of Federal procurement to develop market demand for recovered resources;

(5) recommended incentives (including Federal grants, loans, and other assistance) and disincentives to accelerate the reclamation or recycling of materials from solid wastes, with special emphasis on motor vehicle hulks;

(6) the effect of existing public policies, including subsides and economic incentives and disincentives, percentage depletion allowances, capital gains treatment and other tax incentives and disincentives, upon the recycling and reuse of materials, and the likely effect of the modification or elimination of such incentives and disincentives upon the reuse, recycling and conservation of such materials; and

(7) the necessity and method of imposing disposal or other charges on packaging, containers, vehicles, and other manufactured goods, which charges would reflect the cost of final disposal, the value of recoverable components of the item, and any social costs associated with nonrecycling or uncontrollled disposal of such items.

GRANTS FOR STATE, INTERSTATE, LOCAL PLANNING

207(b)(4)..... Grants pursuant to this section may be made upon application therefor which--

provides for submission of such reports of the activities of the agency in carrying out the purposes of this section, in such form and containing such information, as the Secretary may from time to time find necessary for carrying out the purposes of this section and for keeping such records and affording such access thereto as he may find necessary;

210(c)........ The Secretary shall make a complete investigation and study to determine--

(1) the need for additional trained State and local personnel to carry out plans assisted under this Act and other solid waste and resource recovery programs;

(2) means of using existing training programs to train

such personnel; and

(3) the extent and nature of obstacles to employment and occupational advancement in the solid waste disposal and resource recovery field which may limit either available manpower or the advancement of personnel in such field.

212.......... The Secretary shall submit to the Congress no later than two years after the date of enactment of the Resource Recovery Act of 1970, a comprehensive report and plan for the creation of a system of national disposal sites for the storage and disposal of hazardous wastes, including radioactive, toxic chemical, biological, and other wastes which may endanger public health or welfare.

HRR,11/11/71

MONITORING-RELATED ACTIVITIES TO BE CONDUCTED BY EPA UNDER PENDING LEGISLATION

I. WATER POLLUTION (assumes S.2770 is enacted as passed by Senate)

	S.2770 Section #:	----NOT IN ORDER OF PRIORITY-----
COMPREHENSIVE PROGRAMS	102(a)	Prepare and develop comprehensive programs for eliminating pollution of navigable and ground waters...make joint investigations to that end with other federal and nonfederal agencies
	104(a)(1)...	Conduct...research, investigations, experiments, training, demonstrations, surveys and studies, relating to the causes, effects, extent, prevention, control and elimination of pollution
	(2)...	Render technical services to achieve purposes of (1) above
RESEARCH, INVESTIGATIONS, TRAINING AND INFORMATION	(4)...	In cooperation with the States and other federal agencies, establish, equip, and maintain a water quality surveillance system for the purpose of monitoring the quality of navigable waters, ground waters, waters of the contiguous zone, and the oceans...and report on such quality
	(5)...	Conduct...public investigations concerning the pollution of any navigable waters and report on the results
	(b)(7)...	In carrying out the above provisions,...collect and disseminate basic data on the chemical, physical and biological effects of varying water quality and other information pertaining to water pollution and the prevention and elimination thereof.
	(d)......	The Administrator shall establish, equip and maintain field laboratories and research facilities...for the conduct of research, investigations, experiments, field demonstrations and studies....
GREAT LAKES	(e)......	The Administrator shall conduct research and technical development work, and make studies, with respect to the quality of the waters of the Great Lakes under varying conditions of waste treatment and disposal...
LAKE TAHOE	114(a)......	The Administrator is authorized, in consultation with the Tahoe Regional Planning Agency, to design and carry out projects to develop and demonstrate comprehensive water pollution control programs...such programs and projects shall provide controls over non-point sources and shall maintain and enhance water quality within the Lake Tahoe Basin and may include....(see below)
	(3)...	the development of comprehensive programs for storm water collection and treatment
	(4)..	the development of data on the impact of urban development in the area on regional water quality through soil siltation and other runoff...

INFORMATION AND GUIDELINES	304(h)(1).	The Administrator shall within 60 days of enactment promulgate guidelines re uniform application forms and other minimum requirements for the acquisition of information from owners and operators of point sources of discharge subject to any State program under Section 402 (2) The Administrator shall within 90 days of enactment promulgate guidelines re minimum procedural and other elements of any State program under Section 402 which shall include (A) Monitoring requirements, (B) Reporting Requirements, (C) Enforcement Provisions
WATER QUALITY	305(a)...	The Administrator shall, in coop. w/States, prepare a report to be submitted to Congress on or before July 1, 1973, which shall: (1) --Describe the specific quality, as of Jan. 1, 1973, with appropriate supplemental descriptions as...take into account the seasonal, tidal, and other variations, of all navigable waters and the waters of the contiguous zone... (3)--identify specifically those navigable waters the quality of which (A) is adequate to provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allow recreational activities in and on the water (B) can reasonable be expected to attain such level by 1976 or 1981 (C) can reasonably be expected to attain such level by any later date....
INSPECTIONS, MONITORING AND ENTRY	308(a)...	Whenever required to carry out the purposes of this Act, including (2)determining whether any person is in violation of any..effluent limitation, prohibition, or effluent standard, pretreatment standard, or standard of performance... (A) the Administrator shall require the owner or operator of any point source of pollution to (iii) install, use, and maintain such monitoring equipment or methods (including where appropriate biological monitoring methods) (iv) sample such effluents, and (v) provide such other information as he may reasonably require ------(B) The Administrator or his authorized representative....(i) shall have a right of entry... and (ii) may at reasonable times have access to and copy any records, inspect any monitoring equipment.....and sample any effluents which the owner or operator of such source is required to sample....
OIL AND HAZARDOUS SUBSTANCE LIABILITY	311(c)(2)	The President shall prepare and publish a National Contingency Plan for removal of oil and hazardous substances. Such..Plan shall provide for efficient, coordinated and effective action to minimize damage from oil and hazardous substance discharges, and shall include... (D))..a system of surveillance and notice designed to insure earliest possible notice of discharges of oil and hazardous substances to the appropriate federal agency
OCEAN DISCHARGE CRITERIA	403(c)(1)	Before the issuance of any permit under Sect. 402, the Administrator shall within 180 days of enactment (and from time to time thereafter) promulgate guidelines for determining the degradation of such waters which shall include...(A) the effect of disposal of pollutants on human health and welfare, incl. but not limited to plankton fish, shellfish, wildlife, shorelines, and beaches..(B)..the effect on marine life..(D) the persistence and permanence of disposal effects..(E) the effect of disposal, at varying rates, of particular volumes and concentrations of pollutants....

MONITORING-RELATED ACTIVITIES TO BE CONDUCTED BY EPA UNDER PENDING LEGISLATION

II. AIR POLLUTION

There is no air pollution control legislation of consequence now pending.

MONITORING-RELATED ACTIVITIES TO BE CONDUCTED BY EPA UNDER PENDING LEGISLATION

III. PESTICIDES (assumes H.R. 10729 is enacted as passed by House)

It is the principal of this bill to place responsibility for the giving of almost all information to EPA in the hands of the producers of pesticides and to give EPA the authority to "undertake such monitoring activities" ... "as may be necessary for the implementation of this Act and of the national pesticide monitoring plan." The implied authority to monitor is therefore very broad for it may in fact be necessary to monitor the production, distribution, and sale of pesticides in order to implement the Act. However, included in the following list are only those sections which apply to monitoring-related activities initiated by EPA, for perhaps half the clauses in the bill could be interpreted as containing implied monitoring authority.

	H.R. 10729 Section #:	----NOT IN ORDER OF PRIROITY----
PESTICIDE REGISTRATION	3(c)(1)(D).....	Each applicant for registration of a pesticide shall file with the Administrator a statement which includes, if requested by the Administrator, a full description of the tests made and the results thereof upon which the claims are based, except that data submitted in support of an application shall not, without permission of the applicant, be considered by the Administrator in support of any other application for registration.
EXPERIMENTAL USE PERMITS	5(c)..........	USE UNDER PERMIT. - Use of a pesticide under an experimental use permit shall be under the supervision of the Administrator, and shall be subject to such terms and conditions and be for such period of time as the Administrator may prescribe in the permit.
	(d)..........	STUDIES. - When any experimental use permit is issued for a pesticide containing any chemical or combination of chemicals which has not been included in any previously registered pesticide, the Administrator may specify that studies be conducted to detect whether the use of the pesticide under the permit may cause substantial adverse effects on the environment. All results of such studies shall be reported to the Administrator before such pesticide may be registered under section 3.

REGISTRATION OF ESTABLISHMENTS

7(c)(2)........Any such producer shall, upon the request of the Administrator for the purpose of issuing a stop sale order pursuant to section 13, inform him of the name and address of any recipient of any pesticide produced in any registered establishment which he operates.

BOOKS AND RECORDS

8(a)...........The Administrator may prescribe regulations requiring producers to maintain such records with respect to their operations and the pesticides and devices produced as he determines are necessary for the effective enforcement of this Act.

(b)...........For the purposes of enforcing the provisions of this Act, any producer, distributor, carrier, dealer, or any other person who sells or offers for sale, delivers or offers for delivery any pesticide or device subject to this Act, shall, upon request of any officer or employee of the Environmental Protection Agency or of any State or political subdivision, duly designated by the Administrator, furnish or permit such person at all resonable times to have access to, and to copy: (1) all records showing the delivery, movement, or holding of such pesticide or device, including the quantity, the date of shipment and receipt, and the name of the consignor and consignee; or (2) in the event of the inability of any person to produce records containing such information, all other records and information relating to such delivery, movement, or holding of the pesticide or devices.

INSPECTION OF ESTABLISHMENTS

9(a)...........For purposes of enforcing the provisions of this Act, officers or employees duly designated by the Administrator are authorized-

"(1) to enter, at reasonable times, any establishment; and

"(2) to inspect and obtain samples of any pesticides or devices, packaged, labeled, and released for shipment, and samples of any containers or labeling for such pesticides or devices.

(b)..........For purposes of enforcing the provisions of this Act .... officers or employees duly designated by the Administrator are empowered to obtain and to execute warrants authorizing -

"(1) entry for the purpose of this section;

"(2) inspection and reproduction of all records showing the quantity, date of shipment, and the name of consignor and consignee of any illegal pesticide or device found in the establishment and in the event of the inability of any person to produce records containing such information, all other records and information relating to such delivery, movement, or holding of the pesticide or device; and

"(3) the seizure of any pesticide or device which is in violation of this Act.

UNLAWFUL ACTS

12(b)(2).......The penalties provided for a violation of paragraph (1) of Subsection (a) shall not apply to any carrier while lawfully shipping, transporting, or delivering for shipment any pesticide or device, if such carrier upon request of any officer or employee duly designated by the Administrator shall permit such officer or employee to copy all of its records concerning such pesticide or device.

RESEARCH AND
MONITORING

20(a)..........RESEARCH. - The Administrator shall undertake research, including research by grant or contract with other Federal agencies, universities, or others as may be necessary to carry out the purposes of this Act, and he shall give priority to research to develop biologically integrated alternatives for pest control. The Administrator shall also take care to insure that such research does not duplicate research being undertaken by any other Federal agency.

(b)..........NATIONAL MONITORING PLAN. - The Administrator shall formulate and periodically revise, in cooperation with other Federal, State, or local agencies, a national plan for monitoring pesticides.

(c)........... MONITORING. - The Administrator shall undertake such monitoring activities, including but not limited to monitoring in air, soil, water, man, plants, and animals, as may be necessary for the implementation of this Act and of the national pesticide monitoring plan. Such activities shall be State, and local agencies.

MONITORING-RELATED ACTIVITIES TO BE CONDUCTED BY EPA UNDER PENDING LEGISLATION

IV. RADIATION

Though there are some radiation bills pending on the Hill which would transfer many of the Atomic Energy Commission's responsibilities to EPA, none of them is likely to be passed, therefore, no summary of their monitoring clauses will be included here.

V. NOISE POLLUTION

There is presently one bill pending in each House of Congress which is leading the way but neither has yet come to a vote. In the House of Representatives a subcommitte has written and referred H.R. 11021 to the full committee on Interstate and Foreign Affairs. This bill has apparently overtaken the administration noise bill (H.R. 5275) and is the most likely to pass. In the Senate, the administration bill, (S. 1016), with substantial amendments by the Senate, has been submitted to two committees, Commerce, and Public Works. Both bills contain some enforcement authority and some monitoring-related responsibilities for EPA. These are listed below.

H.R. 11021 ----NOT IN ORDER OF PRIORITY----

Section #:

FEDERAL PROGRAMS

4(b)(1)........Each Federal agency shall, upon request, furnish to the Administrator such information as he may reasonably require to determine the nature, scope, and results of the noise-research and noise-control programs of the agency.

(2)........If at any time the Administrator has reason to believe that a standard or regulation, or any proposed standard or regulation of any Federal agency, respecting noise, does not protect the public health and welfare to the extent he believes to be required and feasible, he may request such agency to review and report to him on the advisability of revising such standard or regulation to provide such protection.

5(b)..........	NOISE CRITERIA AND CONTROL TECHNOLOGY	The Administrator shall, after consultation with appropriate Federal agencies, compile and publish a report or series of reports (1) identifying products (or classes of products) which in his judgment are major sources of noise, and (2) giving information on techniques for control of noise from such sources. This information shall include such data as are available on the technology, costs, and alternative methods of noise control. The first such report shall be published not later than eighteen months after the date of enactment of this Act.
7(d)(1).......	AIRCRAFT NOISE AND SONIC BOOM	In prescribing and amending standards, rules, and regulations under this section, the Administrator shall--(1) consider relevant available data relating to aircraft noise and sonic boom, including the results of research, development, testing, and evaluation activities conducted pursuant to this Act and the Department of Tranportation Act;
13(a).........	RECORDS, REPORTS, AND INFORMATION	Each manufacturer of a product to which standards under section 6 or regulations under section 8 apply shall (1) establish and maintain such records, make such reports, provide such information, and make such tests, as the Administrator may reasonably require to enable him to determine whether such manufacturer has acted or is acting in compliance with this Act, (2) upon request of an officer or employee duly designated by the Administrator, permit such officer or employee at reasonable times to have access to such records, and (3) make products coming off the assembly line or otherwise in the hands of the manufacturer available for testing by the Administrator, to the extent required by regulations of the Administrator.
15(b)(5)(D)...	LOW-NOISE EMISSION PRODUCTS	The Administrator shall conduct whatever investigation is necessary, including actual inspection of the product at a place designated in regulations prescribed under subparagraph (A).
(E).........		The Administrator shall receive and evaluate written comments and documents from interested persons in support of, or in opposition to, certification of the class or model of product under consideration.
15(f)........		The Administrator shall, from time to time as he deems appropriate, test the emissions of noise from certified low-noise-emission products purchased by the Federal Government.

S. 1016--Not in order of priority--Section #

9(a).......... Every manufacturer of a product for which applicable regulations have been promulgated under section 6(a) or section 7 shall establish and maintain such records, make such reports, and provide such information (which may include the availability of products coming off the assembly line for testing by the Administrator) as the Administrator may reasonably require to enable him to determine whether such manufacturer has acted or is acting in compliance with this Act and shall, upon request of an officer or employee duly designated by the Administrator, permit such officer or employee at reasonable times to have access to such information and to copy such records.

RECORDS, REPORTS AND INFORMATION

11........... The Administrator is authorized to--

(a). Conduct research, and finance research by contract with other public and private bodies, on the effects, measurement, and control of noise, including but not limited to--

RESEARCH, TECHNICAL ASSISTANCE, AND PUBLIC INFORMATION

(1). investigation of the psychological and physiological effects of noise on domestic animals, wildlife, and property, and determination of acceptable levels of noise on the basis of such effects;

(2). development of improved methods and standards for measurement and monitoring of noise, in cooperation with the National Bureau of Standards, Department of Commerce;

Holly Carroll

Holly Carroll

APPENDIX I

ATTACHMENT ~~1-B~~ 3

EPA Organizational Responsibilities for Monitoring Activities

A. Regional Administrators

To fulfill this monitoring function, the Regional administrators should:

1. Identify regional monitoring needs required to satisfy program objectives;
2. Determine the most effective way to satisfy these needs, i.e., via state support or direct operations;
3. Direct the regional monitoring in accordance with guidance by office of monitoring and using standardized methods and procedures, providing guidance and supervision to State and local monitoring efforts performed through EPA support, and performing direct operations, such as sampling and laboratory analyses, necessary to augment the State and local efforts;
4. Perform special monitoring as assigned by the Administrator of EPA;
5. Perform specific short-term field studies to support enforcement actions;
6. Assist State and local officials in their monitoring activities;
7. Collect, review and evaluate regional environmental data needed for regional management and/or prescribed by Headquarters and transmit data to EPA data bank in accordance with prescribed procedure;

8. Identify to AARM and to the appropriate program office monitoring needs that cannot be satisfied at the regional level (methods development, demonstration systems, national network);
9. Assist Monitoring Techniques Division in field testing methods and instruments designed for routine monitoring.

B. Functional Offices

With respect to monitoring, the Enforcement, Media and Categorical offices should:

1. Conduct source sampling activities related to their special requirements;
2. Conduct field studies to support policy planning and decision making;
3. Identify to DAAM and to regional offices national monitoring needs to support program objectives;
4. Operate environmental data storage, translation, and information presentation systems as requested by their programs and to be compatible with other EPA information systems;
5. Coordinate and assist, through the regional administrators, States and local users in the use of EPA information systems;
6. Perform analyses as part of the information system where required.

C. Office of Monitoring

The Deputy Assistant Administrator for Monitoring should:

1. Develop and operate special monitoring programs for long-term trends, new or newly recognized pollutants and pollutants under consideration for future control;
2. Plan and develop appropriate guidelines for all monitoring systems;
3. Develop and standardize methodology for the collection and analysis of environmental samples and data handling and presentation;
4. Ensure validity and uniformity of environmental quality data so that it can be fully utilized within EPA's information systems;
5. Direct the operation of the U.S. portion of global and international monitoring networks;
6. Provide through the Regional Administrators for technical training and special assistance to regional, State, and local personnel;
7. Provide a public education and information Program;
8. Provide support when requested to the enforcement elements of EPA;
9. Document the overall environmental quality including trends;
10. Provide an overview assessment of the agency's monitoring activities.

APPENDIX 2

FUTURE MONITORING PROGRAM AND METHODS

A.2.1 PROBLEM PERSPECTIVE

The continuing effectiveness of overall EPA activities rests largely on the ability to anticipate and resolve future potential environmental problems before they reach the crisis stage. This places emphasis on the need for effective planning to provide guidelines and specifications for industry cooperation in technology development. It will promote orderly and economic implementation of control measures to improve environmental quality. It can minimize adverse consequences to the environment and economy (as well as to the Agency's image) from such incidents as the recommended shift from phosphates to NTA to phosphates in laundry detergents.

The following paragraphs describe the assumptions on which a monitoring strategy to meet future needs may be based. Monitoring goals and recommendations for priority implementation are also proposed. Based upon resources available to the Agency, the timing for implementation should correspond to the indicated priorities.

A.2.1.1 Assumptions

The consideration of a monitoring strategy is based upon the following assumptions:

1. Budget funds would continue to be tightly limited for the next several years, and therefore new areas of monitoring would be limited to those mandated by statute;

2. Future statutory responsibilities are not considered in detail in formulating specific goals and implementation plans. Nevertheless, the Office of Monitoring should routinely review pertinent proposed legislation for its impact on the monitoring program and as a source of potential longer range monitoring requirements.

3. Future monitoring techniques, at least in the sense of hardware and data collection methods, were considered to be of less importance in the near term than improvement in current methods of interpreting and utilizing data; however, new techniques should be explored for long term improvements.

4. A greater degree of integration of the various existing monitoring systems is desirable, but this should be accomplished by managing coordinated systems in an integrated way, rather than by integrating the system itself. In other words, the critical need is to be able to cross-walk among the different systems for specific projects or purposes. Integration of environmental monitoring to support research is highly desirable. For example, data relating to interaction and transfer of pollutants across environmental media and their related effects on man, biota and materials should be carefully collected, correlated and analysed by means of a system which allows for physical integration and coordination. For programs relating to specific legislation and operational needs, however, integration should be achieved through management coordination. This will require the design and implementation of suitable interface among the various systems to allow for the effective exchange of required data.

A.2.1.2 Monitoring Goals

The overall EPA monitoring goals are stated as:

1. Provision of data for definition and establishment of standards.

2. Provision of data for enforcement of standards.

3. Fulfillment of other statutory requirements, including examination of environmental impact statements.

4. Alerting the public and academic community to environmental hazards.

5. Assuming the role of a reliable source of comprehensive environmental data.

6. Setting standards of excellence in monitoring.

7. Encouraging wider participation of State and local governments in monitoring.

8. Providing data to demonstrate and evaluate the results of EPA programs.

A.2.1.3 Priority Implementation of Monitoring Goals

The strategy for implementing these goals is based upon meeting the primary responsibilities of the Agency, within available resource and time constraints so as to minimize the risk of further environmental degradation and consequent damages. In the detailed implementation of its future monitoring program, the Agency must carefully analyse each monitoring project in light of attaining a proper balance among these factors.

The following recommendations are listed in order of priority.

1. Support for Enforcement Activities

This recommendation reflects the primary mission of the Agency and in the short term should be geared to requirements under existing legislation. Emphasis should be placed on effluent monitoring and related ambient conditions. Because of their proximity to the specific enforcement problems, regional personnel should play the lead operational role. Headquarters should provide assistance in quality control of the monitoring operations in such areas as:

a) routine performance testing

b) ad hoc assistance on specific problems

c) education on rules of evidence

The adequacy of resources to support enforcement should be examined.

2. Provide data for baseline analysis, long-term trends and standard-setting.

Technical requirements should be determined, and resource availability to meet the requirements should be assured at the Headquarters level. This level should review existing baseline programs to determine their adequacy and and necessity. This review must look at frequency of sampling, number of sites needed, specific pollutants covered, adequacy of data for epidemiological and other research purposes, and priorities among the programs. Priorities should consider the pollutant effects on health and the environment, the irreversability of these effects, and the probability of their occurrence.

Receptor monitoring, such as employed by the CHESS and bone radiation monitoring programs should be given more emphasis and its usefulness should be explored for identifying specific monitoring needs in the various media and for its ability to generate data on cause-effect relationships. Its usefulness as the basic method of monitoring, supplemented by media monitoring, should be examined.

[illegible]

Increased reliance should be placed on the use of modelling techniques to improve the collection and use of data. Development of models for the flow of pollutants through the environment is particularly needed. This is a difficult technical problem which must be attacked by the Agency and poses a challenge to the proper organization and implementation of an effective research and monitoring effort. Data monitoring requirements must be preceded by research specifications for cross-media models (e.g. EQUIPS, Materials Balance, Transport and Diffusion).

3. Provide Data on the Attainment of Standards

The utilization and processing of environmental data should also reflect the need to evaluate effectiveness of EPA programs on achieving environmental improvement. To this effect the Headquarters should maintain a surveillance of its own monitoring programs, receiving appropriate data relating to standard compliance and other regulatory requirements in a routine and timely manner.

4. Support Research on New Types of Pollution

The Office of Research and Monitoring should establish a small team of individuals to determine what are potential new pollutants and to apply small-scale short-term techniques for establishing whether there is sufficient probability of a hazard to require large-scale monitoring. This team should make recommendations for longer-term studies and for studies and techniques to scan the media and receptors for potential hazards. A concept of search sampling and monitoring of media samples and correlation with epidemiological and other effects must be implemented. New and improved analytical and pathological techniques including variation in thresholds of human tolerances should be employed for detection along with increased and systematic monitoring of ecological effects. The same concept applies to changing acceptable levels of known pollutants for which standards have been defined.

5. Improve Quality and EPA Utilization of State, Local and Other Data Sources

Increased reliance should be placed on utilizing environmental data from State, local, and other sources when such data can be made available. EPA should provide guidance to States and localities to assure the quality and reliability of their data. This should include guidelines for station siting, standard methods of analysis, etc. The guidance should be supplemented by a voluntary quality control program. EPA should assume responsibility for compelling compliance of the States and localities with the EPA guidelines.

The Agency also should provide and encourage short-term training for Federal and non-Federal persons engaged in monitoring.

6. Insure Adequate Dissemination of Raw and Processed Data to Public and Private Users

EPA should regularly publish key monitoring data in a publication similar to the radiation and pesticide monitoring journals. In addition, there should be published annually a detailed catalog of types of monitoring data available from EPA, including form, where available, and individual point of contact. This could be expanded to cover non-EPA data.

Increased emphasis should be placed on interpreting (as against collecting) data to meet user needs.

A.2.2 FUNCTIONAL ACTIVITIES FOR IMPLEMENTATION OF MONITORING GOALS

Three functional activities dealing with establishing requirements, performing feasibility analyses for improving monitoring techniques and performing advanced development to further prove the merits of new monitoring techniques and systems are discussed in the following paragraphs.

A.2.2.1 Definition and Analysis of Advanced Monitoring Requirements

Three primary objectives of this activity are:

1) determination of long term environmental monitoring needs and objectives,

2) provision for defining and investigating improved and advanced monitoring techniques,

3) definition of research requirements for proving new environmental monitoring techniques through conducting and supporting analytical studies and advanced development.

The approach to realizing these objectives must begin with a thorough review and appraisal of present monitoring activities and developments. This appraisal should categorize the types of monitoring needs being served according to the priorities described in Section A.2.1.3.

Gaps in present programs, along with a separation into present and future needs should be made to provide a starting point for projecting future requirements. Other factors and information sources requiring analysis to support these projections include:

1) implications of current and pending legislation
2) impact of population and industrial growth patterns
3) new developments in industrial processes
4) new developments in conventional and remote sensing technology
5) potential irreversible environmental effects of pollutants
6) reports of special governmental monitoring committees
7) economic and social projections

Characteristic problem areas should be identified with each of the projected needs. These would relate to considerations such as:

a) identification of new pollutants; b) changes in acceptable levels of pollutant amounts and concentrations; c) siting of sensors; d) measurement sensitivity and lower limits of threshold detectability required for scientific, enforcement, or operational purposes; e) need for standardized techniques of measurement and analysis; and f) need for specialized sensing (e.g. biological organisms).

In all media and categorical areas there will be a need for increased emphasis on source and effluent monitoring. An important consideration of this activity is development of a means to insure that proper communication of information to meet new monitoring requirements occur between state/local and regional groups on one hand and between Regional and EPA central headquarters on the other. Inputs to this activity should also come from discoveries through an early warning network.

Some perspective for future monitoring needs based upon specific details of the current situation is presented in Attachment 1.

A.2.2.2 Feasibility Evaluation For Improving Monitoring Techniques

Based upon requirements and objectives of future monitoring needs, proper systems management and planning requires that feasibility of alternative monitoring systems to satisfy the needs be thoroughly examined.

This activity would involve development of a comprehensive survey of new concepts and techniques for environmental monitoring by EPA, other federal agencies, academic institutions, and industry. This survey will be updated on a continual basis and will provide an inventory of new techniques and concepts. State of the art studies must be conducted and awareness of developments must be maintained.

The potential of these concepts must be matched against the monitoring requirements. A set of priorities and potential payoffs for innovative concepts and techniques will be documented and reviewed by the operational programs of EPA on a periodic basis. This document will provide the basis for a development strategy of advanced monitoring concepts.

Specific concepts and techniques for innovative approaches to monitoring will be evaluated against the strategy, and seed funds will be provided to carry through these selected projects to determine feasibility of the concept. Parallel approaches to meet specific requirements will be pursued through the conceptual phase when this is warranted. Criteria for establishing feasibility will include the economic impact and costs and technological considerations such as compatibility with existing equipment and adaptability to a wide range of utilization. Approaches for establishing feasibility will include paper studies, laboratory models and testing, and pilot experiments. Projects for which feasibility of the conceptual phase is demonstrated will be forwarded to other research and monitoring programs for further development. Wide dissemination of the results of these studies will be made as required.

A.2.2.3 Advanced Development

In order to meet a given future monitoring requirement, it may be necessary to proceed initially along several avenues of approach.

At some point the choices will have to be narrowed down to that concept (or two) which seems most feasible in terms of economics, coverage, flexibility, adaptability, etc. The development phase then deals with the initial testing and data validation of the prototype equipment for the advanced technique(s) finally selected.

Whereas many groups within and without EPA may be involved with a particular advanced approach during the early stages (feasibility and evaluation) of its progress, only those groups specifically affected will continue to be involved when the development phase begins. Depending upon available expertise and facilities, the decision will have to be made whether development will be carried out by EPA personnel or by outside contractors.

The development stage serves, in a sense, as the proving ground for new concepts or some unique combination of existing ideas and the transition should be made clear where advanced development ends and engineering development begins. The results of preliminary field testing and development should provide detailed, hard specifications as input for the implementation of engineering development by other appropriate branches of EPA.

ATTACHMENT B.2.1

PRELIMINARY CONSIDERATION OF MEDIA AND CATEGORICAL MONITORING NEEDS

This attachment discusses some examples of the current situation and potential monitoring needs for media and categorical program areas.

B.2.1 Air and Water

There are over 3,000 state and local air pollution measuring sites in the United States in addition to the various Federal air pollution networks shown in Table B-2-1. Of six air pollutants for which ambient standards have been issued by EPA, only two - SO_2 (sometimes sulfation) and particulates - are monitored on an extended geographical basis.

The Continuous Air Monitoring Program (CAMP) operates at six stations. These sites monitor particulates, total oxidants, total hydrocarbons, CO, SO_2, NO_2 and NO. If the focus of this paper changes from research to actual air quality determinations, then wider geographic coverage is necessary.

Air pollution of the upper atmosphere is an area of great concern, especially with regard to the recent SST issue. The collection of accurate data and the formulation of reliable models are obviously necessary steps in resolving this problem. Except for essentially ground level readings, very few data exist for regions above the order of tens of meters. (The AEC collects radioactivity data in the upper atmosphere). This lack points out the need for pollution vs. height profiles. The Smithsonian Institution has suggested the use of

TABLE B-2-1

PRESENT CHARACTERISTICS AND POSSIBLE EXTENSIONS OF FEDERAL AIR SAMPLING NETWORKS

In addition to state and local stations EPA obtains air pollution data from its own National Air Surveillance Networks (NASN). This system comprises several different kinds of networks, and their present features are summarized below:

- Hi-Vol Network: suspended particulates, 247 sites, 26 samples/site/year;
- Membrane Filter Network: suspended particulates (no glass filter interference), 50 sites;
- Particle Size Network: particle size distribution, 11 sites;
- Gas Sampling Network: several gaseous pollutants, 197 sites, 26 samples/site/year;
- Precipitation Network: dissolved air pollutants in rainwater, 16 sites;
- Mercury Network: airborne mercury, 53 sites,
- Condensation Nuclei Network: one site;
- Radiation Alert Network (RAN): airborne radioactive particles and radioactive contamination of rainwater, 73 sites, continuous daily sampling; this network may be phased out due to decreased atmospheric nuclear testing;
- Pesticide Network: airborne pesticides, 12 sites collecting but method for analysis has not yet been fully developed; Future, 40-60 sites.

astronomical observatory data (telluric lines and extinction wavelengths) as a possible means for obtaining long-term (30-50 years) historical atmospheric pollution amounts.

In order to determine relative contributions (e.g., power plants and/or autos) toward air pollution, more emissions data need to be collected from representative sources. This will enable the appropriate agencies to ascertain the effectiveness of various control programs. Motor vehicle certification and recurring maintenance may provide a challenge for development of more effective and lower cost monitoring methods.

Sometimes monitoring is performed too close to sources of pollution which results in deceptively high, nonrepresentative readings for computing an air quality index for a locality. More careful thought needs to be applied in the selection of sites for this purpose. The comments of this and the previous paragraph apply equally well to water pollution monitoring.

With regard to the surface waters of the nation, there are approximately 24,000 water quantity (hydrological data) stations and 10,000 water quality (chemical composition) stations which are operated by local, state, or Federal (principally the Office of Water Programs, EPA, and the Geological Survey) agencies quantity and quality data are sometimes taken at the same site. The Office of Water Programs intends to increase the stream miles covered by water quality monitors from approximately 44,000 stream miles, 5,000 miles of Great Lakes shoreline, and 4,000 miles of coastline and estuaries to 100,000 stream miles, 60,000 miles of Great Lakes shoreline, and 12,000 miles of coastline and estuaries by 1976. These latter figures represent essentially total United States coverage. There is, however, a large disparity in the levels of effort at the various sites in terms of the sampling frequency and the number of parameters measured.

Water pollutants may be classified into physical (undissolved solids, temperature, odor, sediment, oil, etc.) and chemical categories (heavy metals, acids, bases, nutrients, pesticides, etc.). Not only are some of these substances toxic to human, fish, and plant life, but various industries cannot tolerate them in their process water. A more extensive mobile lab network is needed to provide annual or biennial detailed chemical analysis of all major rivers and bodies of water. Aerial surveys and eventually satellite monitoring should be utilized to augment the ground stations, particularly with regard to the physical pollutants.

For water as well as for air monitoring, serious consideration should be given to careful selection of a subset of these sites to serve as standard reference monitoring stations for adequate geographical, urban, remote and pollutant coverage on a systematic basis.

Epidemics of gastrointestinal disease from public drinking supplies are rare now, but the potential for such outbreaks is great; cities and towns cannot afford to become complacent and careless in disinfection practices. Untreated ground water, along with distribution system difficulties, has been the most frequent cause of recent outbreaks. The waterborne epidemic of *Salmonella typhimurium* involving 18,000 persons at Riverside, California, in May and June of 1965 is such an example.

The detection and identification of viruses is a much more complicated procedure than that for bacteria, even if clams, oysters, or other filter feeders are used to concentrate the virus particles. There is no standard simple laboratory procedure for routine examination of water supplies for important pathogenic viruses. Routine virological examination of water would require an enormous drain on resources as compared to bacteriological examination.

It is therefore recommended, pending development of standard routine methods for the detection and identification of pathogenic viruses in water, that drinking water supplies be examined for viral content during viral disease outbreaks. Careful collecting of detailed epidemiological information is required for proper analyses. This is not by any means a routine monitoring task.

B.2.2. Pesticides and Hazardous Substances

The dangerous effects of pesticides are a problem in all three media. The current minimal monitoring of pesticides in air is conducted by EPA; also by the FDA in eight northeastern states. This capability should be extended with the density of monitoring sites being based upon proximity to areas of application (large agricultural areas) and population density. The Working Group on Pesticides proposed in May 1970 that a program be initiated for monitoring airborne pesticides at a minimum of 40 different locations in the country.

Pesticide monitoring in water and on land is performed much more widely and more frequently than in air. A number of governmental agencies are involved in the National Pesticides Monitoring Program. In general, the present networks seem adequate in terms of the number of sites. However, in view of the tremendous numbers of pesticides on the market and the complex analysis procedures, a better knowledge of regional sales statistics would enable technicians to know what pesticides are most likely to occur, thus eliminating costly, unnecessary testing.

Monitoring of heavy toxic metals chlorinated hydrocarbons, organophosphates, herbicides, halides, and dithiocarbonates which may contaminate food supplies is essential; it is also necessary to determine amounts acquired by other means, such as breathing and skin contamination. Low cost, rapid and accurate monitoring techniques are required in these areas.

B.2.3. Radiation

Figure B-2-1 shows that radioactivity in the atmosphere has declined significantly since the cessation of significant atmospheric nuclear bomb testing in the early 1960's. One should examine whether the monitoring programs designed for measuring radioactive fallout should be re-oriented in some way, consistent with national security.

Recent court decisions relating to the necessity of AEC to file complete environmental impact statements regarding power plant construction suggests greater requirements for monitoring radioactivity and water temperatures in the vicinity of power plants. Since

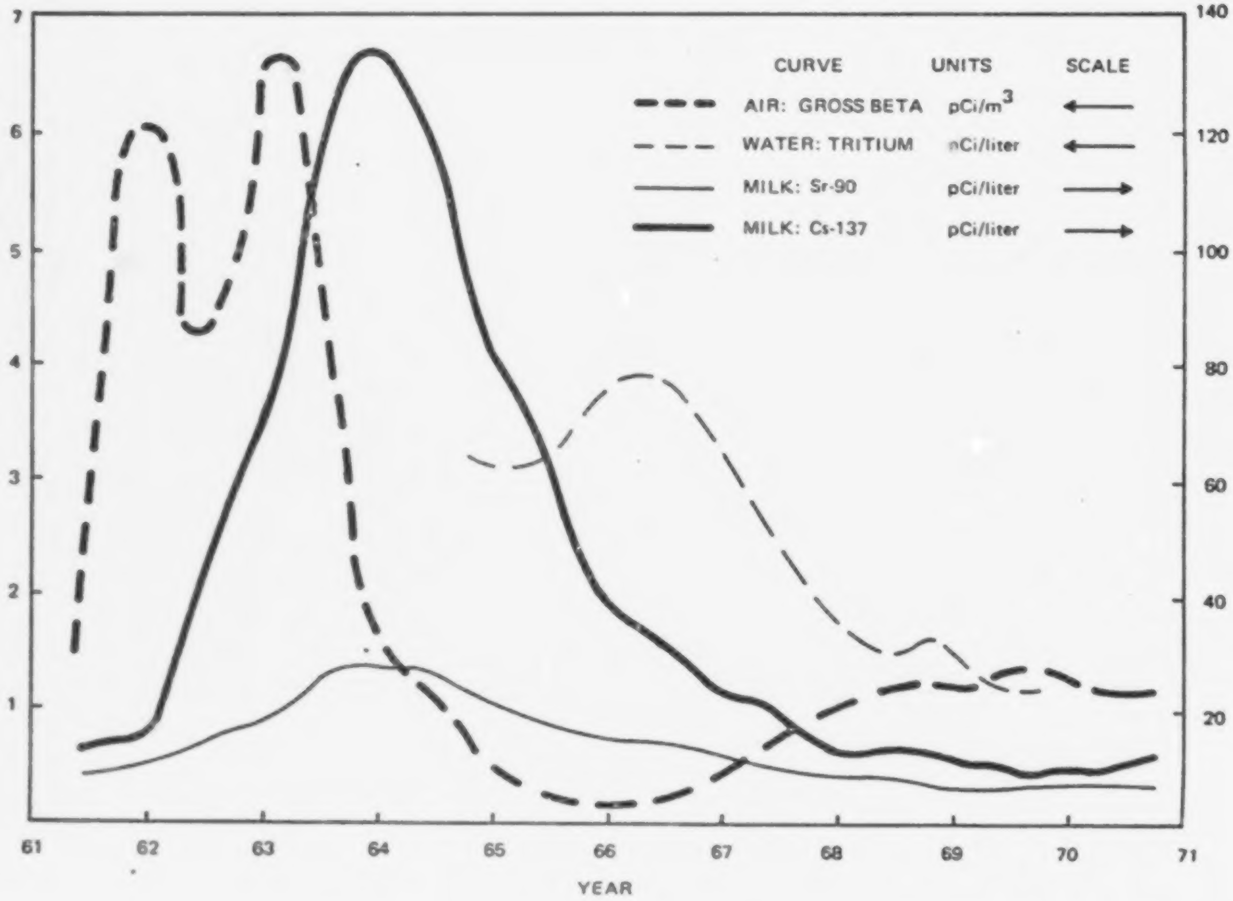

FIGURE B-2-1
SELECTED RADIOACTIVITY TRENDS

indications are that the genetically significant dose (GSD) of radiation from diagnostic x-rays and other non-therapeutic medical sources has increased from 55 millirems in 1964, to approximately 65-90 millirems currently, a better means should be found for monitoring and computing radiation dosage received by the population. Also, the need for monitoring non-ionizing radiation should be investigated.

B.2.4. Solid Waste

Information on solid wastes is mostly concerned with volume, amounts, composition and source. For planning purposes, the Office of Solid Waste would like to know the composition of domestic and industrial refuse in specific locations for large urban areas as well as for rural locations. Often, monitoring consists of physical sorting of garbage which is costly and time consuming and subsequent recording of volume, composition, weight, etc. Scales are sometimes used in measuring loads at incinerator and landfills. In cases of industrial refuse, the data are likely to be obtained from sampling surveys utilizing interviews or written questionnaires. Future monitoring programs in this area should concentrate on developing effective standard techniques for cases where survey and questionnaire are the main monitoring methods available. Are there other methods, more mechanized, more reliable or less costly, of acquiring these data? Certainly these alternatives should be considered in planning new monitoring programs.

Recycling data are important for economic and environmental policy development and legislative studies. A future monitoring program should be concerned with more effective acquisition of materials input and output data from recycling centers and national trade associations (e.g. National Association of Secondary Materials Industries, Institute of Scrap Iron and Steel, National Solid Waste Management Association).

While it may be technically possible to apply IR photography for determination of landfill composition, requirements are needed for use of this kind of data by the Solid Waste Office in order to develop effective plans along these lines.

B.2.5. Noise

Recently the problem of noise pollution has received a great deal of attention, but an organized, carefully conceived monitoring program does not exist. The Bureau of Community Environmental Management has undertaken a few urban surveys, but these are mostly subjective and it would be difficult to make comparisons among cities on a year-to-year basis. The FAA is conducting monitoring in the vicinity of airports to support noise abatement programs. The Department of Transportation also has several studies underway to determine the amount and effects of highway noise. Since general noise monitoring is relatively new, a modest survey program in a few geographical locations (e.g., selected SMSA's) with an extensive deployment of sensing sites should be sufficient until the problem is better understood.

The EPA has recently contracted for studies to describe noise sources (construction equipment, home appliances, etc.) according to characteristics such as intensity, frequency, pitch and other suitable factors. Also, the National Bureau of Standards is providing assistance to EPA to help prepare a report to Congress on the noise control program. The needs of this program should be sharply focused on determination of monitoring research needs. Low cost reliable devices are required for monitoring, recording and analyzing noise signals from various sources (urban streets, construction sites, office buildings, home environment).

B.2.6 Biogeochemical Cycles

There is much concern about ecocycles and ecology textbooks inevitably include diagramatic pictures depicting the transformations among the various physical, chemical, and biological processes involved. However, relatively little substantive knowledge exists on how, when, or where to accurately measure the "health" of such cycles. Biogeochemical cycles, (such as nitrogen, water, oxygen, carbon, phosphorus) are recognized to be fundamental to the support of life on earth. These cycles are complex and are not yet fully understood. The amount of material transported and the vastness of the geographic scope (i.e., the surface of the earth) render any monitoring attempts currently impractical. However, research into their functioning needs to be continued, and monitoring of some limited portion of the cycles may become possible in the future.

APPENDIX 3

STANDARDIZATION OF METHODS & EQUIPMENT

A.3.1 INTRODUCTION

A standard method is a data gathering method that has been tested collaboratively and promulgated as the official method of an organization. Such a standard method is the only legally acceptable method of the organization. A standard method describes the sampling procedure and equipment to be used, the sample handling procedure, the laboratory and/or field analysis procedures for all physical, chemical, biological and microbiological testing. Other methods such as standard reference methods and tentative methods are supportative methods to the standard methods and are described later on in the body of this paper.

The widespread use of an analytical method generally indicates that the method is a reliable means of analysis and this feeling of consensus tends to support the validity of the test results reported. This feeling of consensus is not always valid however, for the method may not have received sufficient screening to uncover possible imperfections. Another but different type of pitfall occurs after a method has been designated a standard method; the standardization tends to inhibit inquiry into the validity and limitations of the method. There is always room for improvement. Conversely, the use of a little-known technique usually forces the data user to place undue faith in the judgment of the analyst. When the analyst uses a "private" method or one not commonly accepted in the field, he stands alone in defining both his choice of the method and the result obtained.

The need for standardization of methods within a single laboratory is readily apparent. Uniform methods between cooperating laboratories are also important in order to remove the methodology as a variable in comparison or joint use of data between laboratories. Uniformity of methods is particularly important when laboratories are providing data to a common data bank, such as STORET, SAROAD, SWIRS, etc., or when several laboratories are cooperating in joint field surveys. The lack of standardization of methods within a single agency raises doubts outside the agency as to the validity of the result reported. If the same pollutant is measured by different analytical procedures within a single laboratory or within several laboratories in the same agency, the question is raised as to which procedure is superior, and why the superior method is not used throughout.

The EPA approach for the selection of standard methods and equipment is the purpose of this paper. The procedure by which a candidate method is selected, tested and finally accepted is described. Organizational questions are addressed also.

A.3.2 GENERAL APPROACH FOR EPA

A.3.2.1 Assignment of Responsibilities

The Standard Methods Branch, Techniques Division, Office of Monitoring is responsible for insuring the establishment of reliable standard methods. This Branch assists in the evaluation and determination of the acceptability of existing methods, sampling location guidelines and equipment use and will provide the technical program policy guidelines in the area of standard methods to the Regional Surveillance and Analysis Divisions of EPA. The main objective of the Standard Methods Branch is to provide leadership in the standardization efforts of all methods and through it actions insure uniformity of analysis throughout all laboratories and programs of the Agency. To accomplish this objective, a working task force group will be established in each environmental component (air, water, solid waste, pesticides, radiation and noise). Representation on each task force group will be taken from all concerned divisions and administrative offices of the Agency, and the Office of Monitoring. The task force group will have the final technical authority for the selection of standard methods. The responsibility for the coordination of all task force group activities and reports resides in the Standard Methods Branch of the Office of Monitoring. This coordination assignment will insure consistent EPA wide policy and methods regarding standard methods and equipment.

The standard methods selected by this approach should then be promulgated by the highest level possible within the Agency. Thus technical approval is performed by the task force groups and administrative authorization (promulgation) is performed by the Techniques Division of the Office of Monitoring.

The certification of EPA Laboratories will be the responsibility of the Office of Monitoring in concert with Office of Program Operations.

A.3.2.2 Mode of Operations with Other Agencies and Organizations

Other Federal organizations are performing significant standardization functions. A strong and continual participation on all Federal interagency standardization committees will be performed by the Office of Monitoring. EPA will use this route to exchange approaches and to gain acceptance of the EPA standard methods by the other Federal organizations. EPA will engender leadership in the field of environmental standard methods development by this participation and forward looking practice.

Relationships with non-Federal (States, industrial organizations, technical societies) standardization groups should also be pursued by the Office of Monitoring. Coordination with such groups will provide valuable source of knowledge and advice. EPA can extend the use of EPA standard methods also by such participations.

A.3.3 SELECTION OF METHODS AND EQUIPMENT

The physical, chemical, biological and microbiological standard methods used by the Environmental Protection Agency (EPA) should be selected using the following criteria:

1. The method should measure the desired constituent with precision and accuracy sufficient to meet the data needs of EPA in the presence of the interferences normally encountered in the media.
2. The procedure should utilize the equipment and skills normally available in the average pollution control laboratory.
3. The selected methods to be used are in many laboratories or have been sufficiently tested to establish their validity.
4. The method should be sufficiently rapid to permit routine use for the examination of a large number of samples.

The use of EPA standard methods in Agency laboratories provides a common base for combined data between program elements. Uniformity throughout EPA lends considerable support to the validity of the results reported by the Agency.

Regardless of the analytical method used in the laboratory the specific methodology should be carefully documented. In some pollution reports it is customary to state that Standard Methods have been used throughout. Close examination in many cases indicates, however, that this is not strictly true. In many laboratories the standard method has been modified because of recent research or personal preferences of the laboratory staff. In other cases the standard method has been replaced with a better one. Statements concerning the methods used in arriving at laboratory data should be clearly and honestly stated. The methods used should be adequately referenced and the procedures applied exactly as directed. When the phrase "EPA Standard Method was used" is to be reported, the exact procedure as detailed in the standard methods manual should have been followed.

Knowing the specific standard method which has been used, the reviewer can apply the associated precision and accuracy of the method when interpreting the laboratory results. If the analytical methodology is in doubt, the data user may honestly inquire as to the reliability of the result he is to interpret.

As mentioned earlier, the advantages of strict adherence to accepted methods should not stifle investigations leading to improved analytical procedures. In spite of the value of accepted and documented methods, occasions do arise when a procedure must be modified to eliminate unusual interference or to yield increased sensitivity. When modification is necessary, the revision should be carefully worked out to accomplish the desired result. It is advisable to assemble data using both the standard method and the modified procedure to show the superiority of the latter. This useful information should then be brought to the attention of the task force group responsible for that methods' standardization. For maximum benefit the modified procedure should be rewritten in the standard format so that the substituted procedure may be used throughout the laboratory for routine examination of samples. Responsibility for the use of a non-standard procedure rests with the analyst and his supervisor since such use represents a departure from accepted practice.

In field operations the problem of transport of samples to the laboratory or the need to examine a large number of samples to arrive at gross values will sometimes require the use of rapid field methods yielding approximate answers. Such methods should be used with caution and with a clear understanding that the results obtained do not compare in reliability with those obtained using standard methods. When deviations from standard methods have been used, they should be noted and the results flagged when included in STORET, SAROAD, etc., along with the more reliable laboratory-derived analytical information. The data user is entitled to know that approximate values have been obtained (for screening purposes only) and that the results do not represent the customary precision and accuracy obtained in the laboratory.

We recognize the importance of using the best available scientific methods throughout. The use of legally valid, uniform, precise, and accurate methods yields important benefits in reliability, improved comparability of data from different sources, and in the consistency of relationships of the EPA with other Governmental Agencies and non-Federal organizations.

The Standard Methods Branch is responsible for coordination and/or direction of all standardization activities within EPA to establish reference and standard methods. This activity will insure the development of measurement techniques which will accurately access the control of pollutants which have been determined to exhibit adverse effects on human health and welfare.

The pollution of our environment cannot be measured adequately or controlled properly without the use of methods which have been collaboratively tested by qualified analysts. Such methods are analysed statistically in order that the reliability and bias is understood exactly. Such a method as defined here and in the introduction is called a standard method. To insure comparability of all data while allowing some freedom of choice, it is also necessary to establish some methods as standard reference methods. Standard reference methods insure a basis upon which less precise but more agile techniques may be tested. EPA will develop Standard Reference Methods with the advice and assistance from other agencies but the final selection is the responsibility of EPA itself.

Standard Methods should meet the following requirements:

a. Demonstrated utility in the laboratory and in the field.

b. Demonstrated freedom from known interferences.

c. Easily measured chemical and/or physical parameters.

d. Relatively inexpensive and available to all people who are required to use the method.

e. Demonstrated reliability through collaborative testing by a representative (but qualified) sampling of the user population.

f. Demonstrated reliable sensitivity for required pollutant concentration ranges.

g. Acceptable (based on the above criteria) to the Administration and to the general user.

When neither standard methods or standard reference methods are available, measurement techniques which represent the best judgment of an expert user-group should be established - tentative method or approved method (EPA).

The validity of all pollution measurements depend on strict adherence to all aspects of standard or approved procedures; the proper use of primary/secondary, gaseous, liquid and solid standards to calibrate the analytical methods and equipment, and the proper handling of the data obtained. EPA's standardization activities should provide: (a) primary and/or secondary gaseous, liquid and solid standards; (b) provide procedures for use in calibrating methods and equipment and establish equivalency between the standard reference method and other methods of choice; (c) provide minimum performance specification required for instruments to measure a specific pollutant or class of pollutants in ambient and sources; (d) provide guidelines for certification of analysts; (e) provide assistance to groups responsible for data handling guidelines, and (f) establish control charts to determine the validity of data generated using standard or approved methods.

Equipment standardization by the task force group is best carried out by the development of standard method, specifications, the evaluation of equipment proposed to meet these specifications, and the selection of referee methods for calibration and evaluation.

A.3.3.1 Detailed Procedure for Development of Standards

Candidate methods for standardization are obtained from operating divisions within the Environmental Protection Agency, other Federal Organizations or from non-Federal organizations. These candidates methods are received by the Monitoring Techniques Division for evaluation, collaborative test direction and promulgation. To accomplish the selection of Standard Methods, working task force groups for each environmental component (air, water, solid wastes, pesticides, radiation and noise) will be used with adequate representation to include all concerned Agency activities.

Methods recommended for standardization are subjected to the following procedures:

a. Preparation. Methods are first drafted into a concise format. Each method is then reviewed extensively and revised by the assigned working task force group in the area of interest (air, water, waste, noise, pesticides, radiation). Each group is composed of representation from all concerned divisions of EPA and should be composed of technical and program office personnel. Outside groups such as the Air Pollution Control Association, American Conference of Governmental and Industrial Hygienists, American Industrial Hygiene Association, American

Public Health Association, American Society for Testing and Materials, American Society of Mechanical Engineers, Association of Official Analytical Chemists, and the American Chemical Society, etc., should be invited to present their methods and to suggest modifications to EPA proposed methods.

b. Preparation of Standard Reference Materials. Before any procedure can be properly evaluated, materials (pollutant species) must be developed. The feasibility of using these materials for calibration and testing must be determined.

c. Test and Evaluation. It can be assumed that the originator of a method can obtain usable results with "his" method even if on the spot changes are required. Therefore, one of the most important steps in the standardization process is an impartial evaluation in the laboratory and in the field by qualified and experienced scientists.

d. Collaborative Testing. Participants in a collaborative test series should be representative of the ultimate users of the method. Since pollution measurements are a matter of concern to many people, the users of the method will include laboratories of the Federal government, state and local pollution control agencies, private industrial plants of many different types, universities, and basic research organizations as required. (To date, approximately 150 laboratories have indicated a willingness to participate in the collaborative testing of air pollution methods). A majority of these are state and local air pollution control agencies, although the other types of laboratories listed above are also represented. The various laboratories also vary in size from one or two-man laboratories up to large organizations with a laboratory staff of several dozen people. A collaborative study is usually done by distributing samples to a group of laboratories for analysis, followed by statistical analysis of the data to provide the desired evaluation of the method. This procedure has been used by many organizations in the standardization of various methods of measurement. The American Association of Analytical Chemists (AOAC) and the American Society for Testing and Materials (ASTM) have been especially active in this field and have published guides to establishing the proper procedure for conducting collaborative or round-robin tests of a proposed method. A test program of this nature has not been conducted in the past to evaluate methods for measuring air contaminants, largely because of difficulty in providing standard samples to a group of laboratories for analysis.

In collaboratively testing for air pollution measurements, it is desirable to develop a system for generating a test atmosphere of known concentration. Where this cannot be done, a group of collaborators come together at a single location and sample a real atmosphere or source. The primary disadvantage here is one of statistical validity. Ideally, a collaborative test should indicate what each participant is capable of doing in his own laboratory, and not at some central location. This method inevitably suffers from the fact that the results more nearly indicate an intra-laboratory evaluation than an inter-laboratory evaluation.

e. Adoption. Based on the statistical evaluation of the data from the collaborative tests, the task force groups will determine if these methods should be adopted as standard methods. Other groups are free to use these data to decide which methods they choose to endorse.

f. Promulgation. Methods adopted as standard methods by EPA will be promulgated. All state and local agencies will be directed to use the standard methods in implementing their programs. As stated previously, standard methods should be promulgated by the highest level possible in EPA.

g. Quality Control. Continuing subsequently to the adoption of each standard method, a quality control procedure will be established to insure the attainment of accurate data. State and local laboratories, on a voluntary basis, will be served through the Regional Offices of EPA. Quality Control is closely related to standardization of methods in that it is the inverse of collaborative testing. While collaborative testing evaluates the reliability of methods, quality control evaluates the reliability of data using the methods.

A.3.3.2 Specific Factors Relating to Standard Methods and Equipment

The procedures described in the preceding paragraphs for implementing measurement standard methods must consider the following factors:

1. Siting of sensors - guideline documents for each specific application
2. Measurement precision and accuracy
3. Calibration and maintenance
4. Averaging times and averaging methods
5. Measurement errors - bias and random
6. Data entry and reporting - editing and validation
7. Impact on data processing

The definition and initiation of procedures, techniques and equipment characteristics is a function of standard setting. The maintenance procedures relating to these factors is a function of quality control.

Standards for site selection cannot and should not be developed. Site selection should be tailored to the purpose of the monitoring. A guidelines document which outlines the points to be considered for various types of data gathering should be prepared.

A.3.4 NEED FOR STANDARD DATA HANDLING PRACTICES

Associated with monitoring activities is a massive accumulation of data which must be formatted and reduced for quick assimilation. Fortunately, there are a number of institutions throughout the United States which have experience in data reduction and analysis. It would be advantageous for each region to avail themselves of this already existing capability. However, before these channels of data processing are utilized, it is most important that unified standards for formatting and data reduction be established.

The alternative to standardization in the realm of data management would be utter chaos. However, standardization of data management practices will be a complex project since no standard guidelines exist to date. To delay implementing this objective would only complicate an already difficult task. For this reason and also because data management is so basic to remote and in-situ monitoring operations, the standardization of data management practices should receive the very highest priority.

Close coordination between the standards for data coding, storing, retrieving, analyzing and summarizing and the monitoring techniques standards must be developed and maintained.

APPENDIX 4

EARLY WARNING MONITORING NETWORK

A.4.1 PROBLEM PERSPECTIVE

To fulfill its enforcement mission, the Environmental Protection Agency is required to implement, coordinate and support abatement activities to prevent environmental degradation and to support environmental improvement. Knowledge of the environmental state is required before any action can be taken. Some phenomena such as air pollution episodes, oil spills and industrial or transportation accidents involving lethal substances occur suddenly and pose immediate (i.e. within hours, extending for several days or weeks) hazardous effects to man, animals, vegetation and natural resources. Other phenomena such as the build-up of CO_2 in the atmosphere, decline of solar radiation at the earth's surface and the concentration of organic mercury, lead, cadmium and other substances in plants and animals occur more gradually but may have potentially disastrous long term effects on the environment and the earth's inhabitants. The Agency must have the capability to respond to these occurrences and exercise control in a rapid manner, consistent with the time scale of the phenomena encountered. This capability must be met by an Environmental Early Warning System. The response to short term events can be best met by capability at the regional level while early detection of long term hazards can best be handled by a system at the Headquarters level. An early warning capability is a critical need to permit the Agency to perform its enforcement and abatement mission.

A.4.2 EARLY WARNING FOR SHORT-TERM EPISODES

An early warning network to meet short-term episode needs is characterized by rapid detection, reporting, communication, remedial action and control response. Elements of such a system must provide for centralized display in the region to support management, operational planning, and control of episodes as well as for rapid dissemination of data and operational instructions for effective and prompt local action. This will allow the managers to be aware of tactical developments and quickly draw upon resources under their control (or request additional resources) to exericse initiatives, capitalize on auspicious developments or take actions to thwart unfavorable developments. A solution to this problem calls for operation of an Environmental Situation Room (ESR) at the regional level, supported by the necessary sensors, communications links, information processors and displays. A functional depiction of an early warning subsystem in support of abatement actions is shown in Figure A-4-1. The input measures and forecasts which are routinely collected and processed by local agencies, private sources and Federal agencies normally would be stored in various central and regional processing centers to support routine operations. Special techniques should also be employed specifically for rapid alert purposes. For example, the Radiation Alert Network provides gross measures of radioactivity so that significant changes would provide alert for more detailed monitoring. Also, the National Weather Service issues forecasts relating to alerts of prospective episode conditions and are distributed through the Weather Service channels. More use

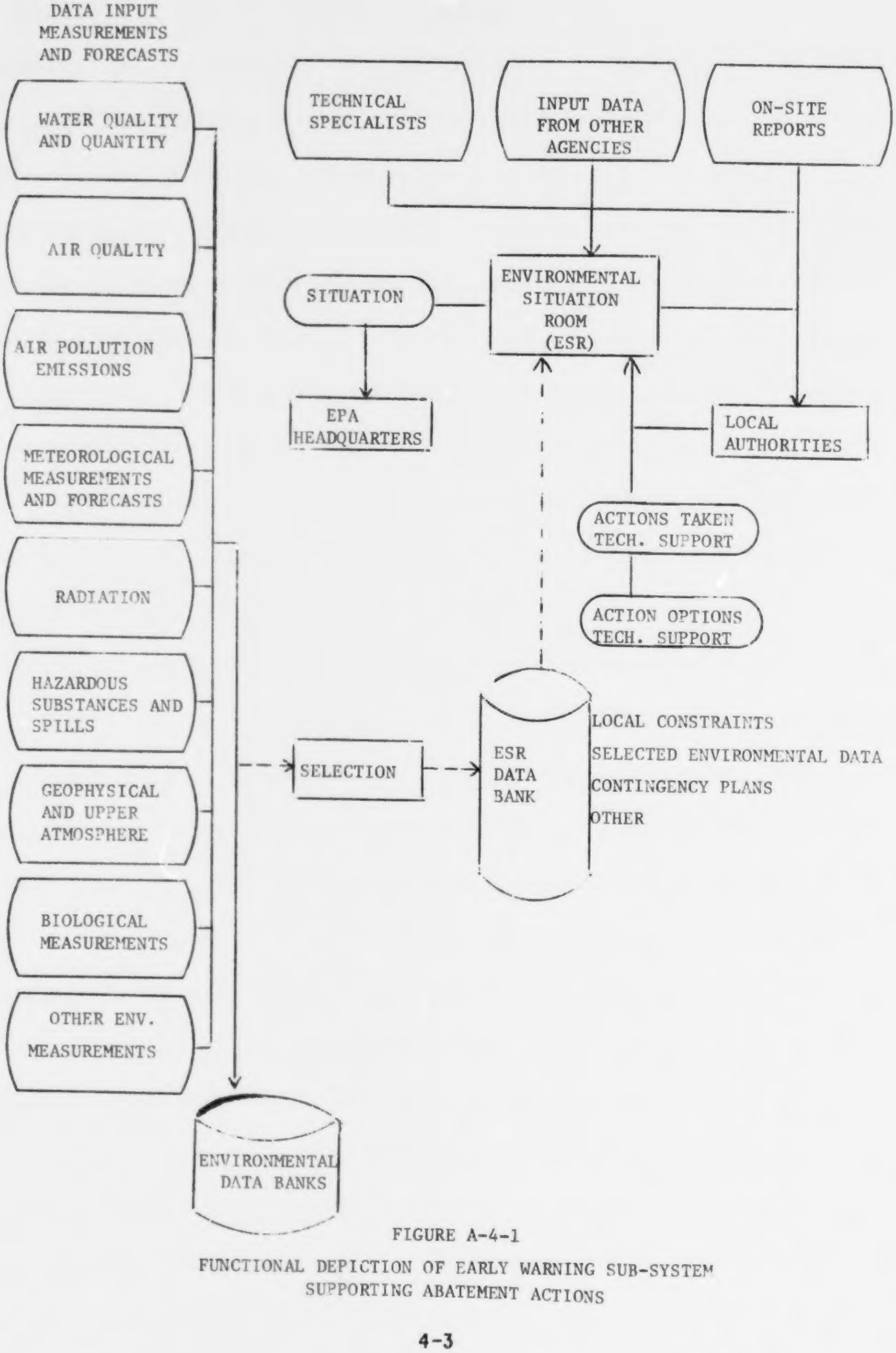
DATA INPUT MEASUREMENTS AND FORECASTS
WATER QUALITY AND QUANTITY
AIR QUALITY
AIR POLLUTION EMISSIONS
METEOROLOGICAL MEASUREMENTS AND FORECASTS
RADIATION
HAZARDOUS SUBSTANCES AND SPILLS
GEOPHYSICAL AND UPPER ATMOSPHERE
BIOLOGICAL MEASUREMENTS
OTHER ENV. MEASUREMENTS
ENVIRONMENTAL DATA BANKS
TECHNICAL SPECIALISTS
INPUT DATA FROM OTHER AGENCIES
ON-SITE REPORTS
SITUATION
ENVIRONMENTAL SITUATION ROOM (ESR)
EPA HEADQUARTERS
LOCAL AUTHORITIES
ACTIONS TAKEN TECH. SUPPORT
ACTION OPTIONS TECH. SUPPORT
SELECTION
ESR DATA BANK
LOCAL CONSTRAINTS
SELECTED ENVIRONMENTAL DATA
CONTINGENCY PLANS
OTHER

FIGURE A-4-1

FUNCTIONAL DEPICTION OF EARLY WARNING SUB-SYSTEM SUPPORTING ABATEMENT ACTIONS should be made of utilizing biological techniques for early warning indication. Water samples should be taken routinely to determine the number and types of organisms present. Frequently, a reduction in the number of species indicates presence of toxic substances.

Data obtained from these special techniques would be selected routinely for regional analysis required to support the operation of the ESR. Additionally, during critical episodes such as an oil spill, an accident involving transportation of hazardous materials, an air pollution episode or contamination of drinking water in a community, the selection function would be enacted to tap relevant data during its flow for normal operational use. Also, special actions would be taken to increase the surveillance of the affected area. In the case of air pollution incidents, for example, mobile monitoring stations might be dispatched to measure emissions, ambient concentrations and pertinent meterological parameters on a micro-level basis. In the case of accidents, mobile monitoring would also be enacted. In all such instances, on-site reports would be available to local authorities and to the ESR. Information would be sent via teletype, data-phone and by normal telephone communication.

Situation managers in the ESR would have access to all incoming relevant data as well as to technical specialists. A data bank must be maintained to contain the selected environmental data, contingency plans and other technical support information.

Contingency plans for a variety of possible scenarios should have been prepared to allow maximum utilization of standard guidelines, action alternatives and standard operating procedures which could be responsive to a given situation. This would assist in making prompt decisions and avoiding issuance of conflicting instructions and other inconsistencies likely to accompany an environmental crisis situation. The advantages of having available plans for a variety of situations would increase the effectiveness of federal support, expedite coordination among EPA, other federal agencies (e.g. Office of Emergency Preparedness) and local authorities and promote implementation of proper abatement actions. Direct actions may be taken on a regional basis; action options, advice and coordinated instructions in any case would be issued in accordance with administrative, legal and other jurisdictional constraints. EPA Headquarters would be kept informed via telephone through periodic situation reports.

Technical support data should be accessible to the ESR manager as required. This could include processed information in the form of population data for major areas, location of key resources and services and transportation facilities. A file of such data should be available in the ESR. Any required data not in the file could be obtained through coordination with other agencies and the local jurisdiction involved.

The ESR should be equipped with specially designed displays for use during emergency situations. A map of the area involved should be available to the scale required by the situation. A status board indicating such items as actions taken (e.g. shutdown orders issued, shutdown accomplished, population evacuated from area A), and numerical parameters of interest should be provided, with capability for interrogation of the ESR data bank. The specifications for such displays should be developed from a detailed requirements analysis of regional activities.

A.4.3 IMPLEMENTATION AT THE REGIONAL LEVEL

To properly design a regional ESR, a study should be made of the pertinent activities and relationships among regional personnel and state, local, and private groups. The study should identify particular event categories for each of the areas of concern. The entries in this matrix would identify specific events, as partially illustrated in Figure A-4-2.

The next step would require identification of input characteristics, actions available and outputs for each entry in a cell. This would involve such factors as:

- Inputs

  Amount of substance
  Type of substance
  Location
  Responsibility for action
  Time of occurrence

- Actions

  Field consultation
  Abatement activities
  Monitoring and surveillance
  Coordination activities

- Outputs

  Situation reports
  Summary report of event
    Resources expended
    Actions taken

AREAS OF CONCERN EVENT CATEGORIA	WATER	AIR	RADIATION	PESTICIDES	SOLID WASTE	NOISE
PHYSICAL OCCURRENCES	OIL SPILLS HAZARDOUS MATERIAL SPILLS	EPISODES HAZARDOUS MATERIAL RELEASE	TRANSPORTATION SPILL	TRANSPORTATION SPILL		
CONTROL FAILURES	WASTE TREATMENT INDUSTRIAL PROCESSES DRINKING WATER TREATMENT	EMISSION CONTROL FAILURE	WASTE TREATMENT INDUSTRIAL PROCESSES WASTE STORAGE LEAKS	INAPPROPRIATE APPLICATION STORAGE AND DISPOSAL	SANITARY LANDFILL ENVISION INCINERATORS	INDUSTRIAL PROCESSES
ABNORMAL EFFECTS	REPORTED HEALTH EFFECTS e.g. GASTRO INTESTINAL	REPORTED HEALTH EFFECTS e.g. EYE IRRITATION	REPORTED HEALTH EFFECTS	REPORTED HEALTH EFFECTS	REPORTED HEALTH EFFECTS	REPORTED HEALTH EFFECTS

FIGURE A-4-2

ILLUSTRATION OF EARLY WARNING EVENT MATRIX

The detailed description of needs at the regional level would provide a basis to develop an operational design concept for the ESR. This would include specifications for sensing devices, communications and processing equipment, displays, procedures and operational responsibility.

A.4.4 EARLY DETECTION OF LONG TERM AND NEW ENVIRONMENTAL HAZARDS

The central feature of the operational concept presented for this subsystem (Figure A-4-3) is an Environmental Intelligence Analysis Center (ENVIAC) at the Headquarters level. The functions of this center would consist of gathering and sifting through environmental intelligence data, developing environmental models (taking into account activities of other environmental research groups), applying these models and conducting long-term environmental assessment studies. The output of this Center would:

1) Provide warning reports of newly discovered potential environmental hazards

2) Identify new research requirements

3) Prepare plans for rapid implementation of detailed surveillance of specific pollutants in particular locations as a result of detection of a potential environmental hazard

4) Perform special impact analyses

5) Provide evidence for specific environmental policy recommendations.

Results of items 1), 2) and 4) would be disseminated to research and analysis groups within EPA as well as to other agencies and research establishments. Item 3) would be directed to the operational group

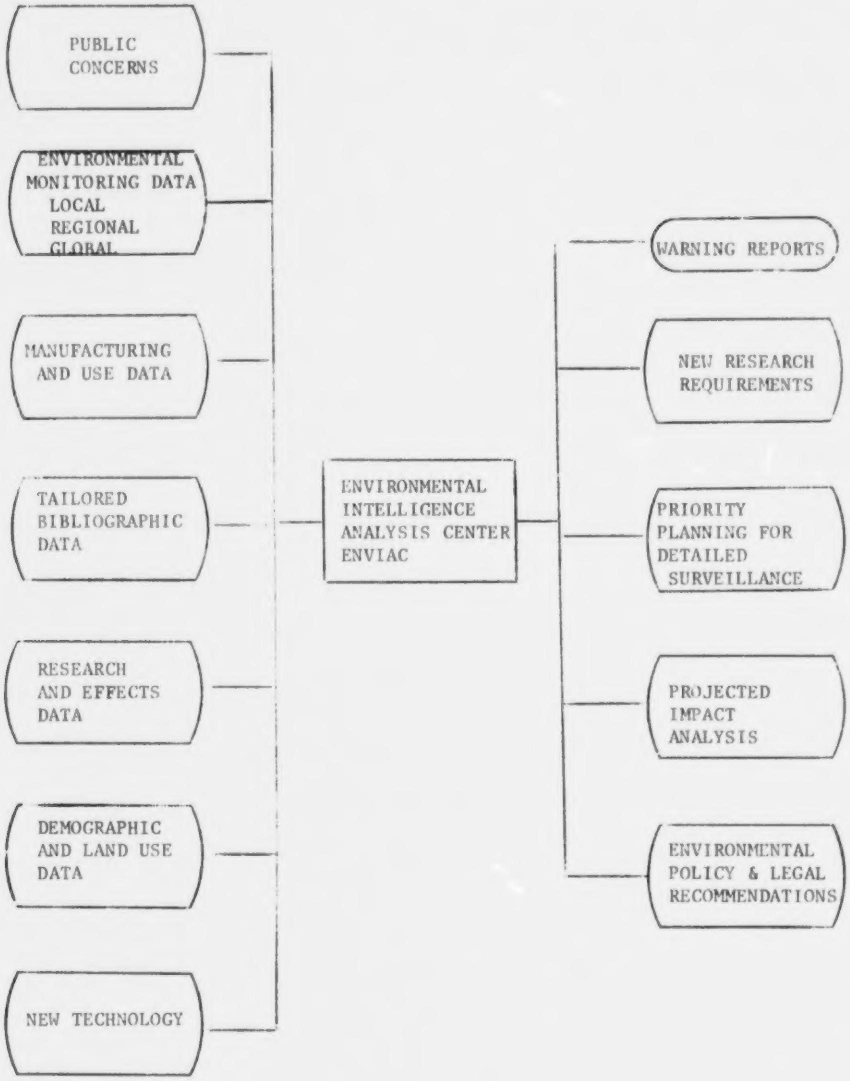
PUBLIC CONCERNS
ENVIRONMENTAL MONITORING DATA LOCAL REGIONAL GLOBAL
MANUFACTURING AND USE DATA
TAILORED BIBLIOGRAPHIC DATA
RESEARCH AND EFFECTS DATA
DEMOGRAPHIC AND LAND USE DATA
NEW TECHNOLOGY
ENVIRONMENTAL INTELLIGENCE ANALYSIS CENTER ENVIAC
WARNING REPORTS
NEW RESEARCH REQUIREMENTS
PRIORITY PLANNING FOR DETAILED SURVEILLANCE
PROJECTED IMPACT ANALYSIS
ENVIRONMENTAL POLICY & LEGAL RECOMMENDATIONS

FIGURE A-4-3

LONG TERM EARLY WARNING SYSTEM

within EPA having responsibility for operating special surveillance systems supporting ENVIAC (discussed below). Technical back-up for policy recommendations would be made available to EPA decision makers and other policy groups (e.g. CEQ, OST).

In addition to relying on its own analysts, the Center would be supported by three major elements:

1) Other Research and Analysis Groups
2) Data from Special Surveillance Networks (operated in a region of concern)
3) Bibliographic Dissemination Service.

ENVIAC would also have access to other Federal environmental data banks and would receive inputs from global monitoring sites.

Research and analysis groups will provide two types of input to ENVIAC. Discoveries of potential hazards, either through field experimentation or data analysis, should be immediately sent to ENVIAC. Other publications and reports prepared by the environmental research community pertaining to new environmentally oriented scientific discoveries should be classified and disseminated to the Center through a bibliographic and dissemination service. This service should also provide inputs regarding pertinent research in - progress. In addition, the analysts in the Center would have to obtain manufacturing and use data for hazardous substances to determine the potential extent of a problem. Land use data and information on new technology would also be employed to permit the analysts to prepare their outputs.

The recently completed Study of Environmental Quality Information Programs (SEQUIP) for the Office of Science and Technology made some specific recommendations regarding dissemination services (see Attachment B.4.1). The SEQUIP Committee recommended that the Science Information Exchange of the Smithsonian Institution and the National Technical Information Service be combined for this purpose. The Center for Short Lived Phenomena, also of the Smithsonian Institution, currently collects and selectively disseminates information relating to new discoveries and field observations for a variety of subject categories. (The MITRE Corporation, in its monitoring system study for the CEQ suggested a Scientific Environmental Research Volunteer in Cooperative Effort - SERVICE Group to report on new and potentially significant environmental developments). The SEQUIP Committee also recommended that various centers of environmental research allow scientists some time to classify and report on new findings. Better coverage of environmental material in secondary journals is also suggested. There appears to be wide interest in establishing and accomplishing such a system to meet these needs. All that appears to be required is strong leadership and competent management to launch and conclude the design and implementation effort.

Special surveillance networks (including necessary laboratory resources) should be established to provide direct environmental data specifically tailored to support ENVIAC's mission. Data from these networks, which could also be made available to other research groups, would measure parameters such as CO_2, atmospheric turbidity and solar radiation and other geophysical and upper atmospheric pollution data. In addition, elements of this network would consist of biological monitoring organisms (indicators, sentinels, bio-assay, detection and accumulation) for detection of quantities of key pollutants. Since there are 2.5 million known chemical compounds and 500 new chemical compounds introduced annually into the environment by industrial countries, there is certainly a problem in selecting the specific representatives in each class. In this way, if subsequent research indicates that another (unmonitored) substance in the calss has hazardous environmental characteristics it may be that the representative of the class which was being monitored would have transport characteristics and other properties which were similar to the substance being monitored. In this case, some further clues may be available about the possible intermedia properties of the newly detected hazardous substance.

Any substance chosen for monitoring should be measured in air, water and land, as well as in possible species in which it might concentrate. Correlations should be performed by ENVIAC to attempt to relate concentrations to effluent amounts. Requirements for the surveillance networks include standard methods of analysis and provision of timely dissemination of results to interested specialists. Immediate reporting capability is generally not required. There should be sufficient flexibility in the surveillance networks to receive instructions from ENVIAC for increased surveillance for areas of specialized interest, as dictated by results of intelligence evaluation and other pertinent findings.

ATTACHMENT B.4.1

REVIEW OF STUDY OF ENVIRONMENTAL QUALITY INFORMATION PROGRAMS (SEQUIP) IN THE FEDERAL GOVERNMENT

B.4.1 - INTRODUCTION

This Attachment presents a review of the subject document which was prepared under the direction of Dr. Henry Kissman of the National Library of Medicine, who served as chairman of the SEQUIP committee. Thirteen members constituted the committee representing HEW, AEC, Departments of Interior and Agriculture, National Bureau of Standards, NOAA, Defense Documentation Center, EPA and the Library of Congress. The report consists of general findings of the committee and special sections on information technology, water pollution, air pollution, solid waste management, environmental effects of radiation and agriculture chemicals. It also consists of a directory of general information programs and public health information programs as well as a directory of environmental pollution information and data programs. While the task of the committee, as specified by OST, was to investigate broad environmental quality programs, only environmental pollution was considered in the report to limit the scope. The report states, however, that activities associated with data collection and information systems are generally applicable to programs outside the environmental area.

The objectives of the committee's study were threefold:

1. Report on studies of scientific and technical information activities in federal agencies concerned with environmental projects and improvement.
2. Describe generalized information programs (e.g. national libraries, clearing house) which serve the environmental quality field.
3. Assess whether the support activities are sufficient and, if not, determine how they can be improved.

This Attachment summarizes the major recommendations offered in the report.

B.4 .2 - RECOMMENDATIONS

2.1 General

1. OMB promote data and information exchange within the Federal establishment by developing procedures for cost recovery.

The committee felt that duplication exists in data and services because operators of information systems are reluctant to offer services outside of their own organizations, because of lack of resources.

2. CEQ create in EPA a NATIONAL ENVIRONMENTAL PROTECTION AND INFORMATION DATA SERVICE (NEPIDS).

Inside of EPA this group would pull together the networks absorbed by EPA, promote standards, coordinate R&D, develop data in the technical environmental areas and answer queries within the agency. Outside of EPA this group would initiate network operations to interface with other environmental data banks, provide information relating to types and status of R&D projects, respond to requests, and work with the National Bureau of Standards and coordinate the information with other agencies.

3. This group should take into account requirements of future economic growth and the global aspects of pollution monitoring.

4. The National Bureau of Standards be assigned responsibility for developing:

a. standards relating to software development and operation of data banks.

b. environmental assessment technology including modeling and simulation.

c. clearing house activities.

d. systems analysis teams to aid agencies in establishing the necessary interface.

It was proposed that a major part of the fundings for this effort be provided by EPA and NOAA. Dr. David Freeman, Chief, Separation and Purification Section, Analytical Chemistry Division, and Dr. David Wagman, Institute for Materials Research were the National Bureau of Standards representatives on the Committee.

5. Continue workshop and symposia activities via a formal mechanism to be established by the Council on Environmental Quality or COSATI.

This recommendation is offered to stimulate communication among those concerned with environmental information programs.

6. The National Referral Center of the Library of Congress develop tools for improved access to technical information in the environmental quality field.

It was specifically recommended that LC publish a directory of U.S. Information Resources in the Environmental Quality Area.

7. A single government-wide clearing house be established to consolidate the activities of such groups as the Science Information Exchange (SIE) of the Smithsonian Institution and the Technical Information Service of the Department of Commerce.

It was further recommended that OMB establish guidelines and enforce government wide mandatory input requirements for standardization on an agency wide basis.

8. A national environmental early warning system for monitoring environmental pollution be incorporated as part of the Center for Short Lived Phenomena of the Smithsonian Institution.

9. Establish a Hazardous Materials Information Center to be operated by the Coast Guard and DOT.

The center would collect information on hazardous materials, cover procedures of handling, and methods of detoxification.

10. A new COSATI panel on environmental quality information and data systems be established to follow-up on these recommendations and to extend the SEQUIP study into other non-pollution environmental areas (e.g. wetlands, urban environmental sources).

B.4.2.2 Bibliographic Services

Fourteen recommendations of a bibliographic nature dealing with data dissemination services, clearing house operations, document indexing, preparation of dictionary and thesaurus and preparation of abstracts were presented. These are not detailed in this Attachment.

B.4.2.3 Water Pollution

The report mentioned that the Office of Water Data Coordination and the Office of Water Resource Research currently provides a "sinew for an effective federal-wide interagency data and information network in the water resource aspects of environmental pollution". STORET was mentioned as a data resource but no comments were made regarding its current effectiveness.

B.4.2.4 Air Pollution

1. Use existing programs as a basis for satisfying new needs.

This recommendation is generally similar to that offered by the MITRE Corporation in a study performed for CEQ.

2. Unite pollution monitoring with the meteorological data collection system.

This recommendation has a significant impact on siting and data storage. The report pointed out, however, that a technical unification did not necessarily imply organizational consolidation for operation and administration of the networks.

3. Expand and optimize air pollution sampling networks.

4. Institute administrative and legislative steps required to promote Items 2 and 3.

5. Compatibility with and accessibility to existing data banks be a required consideration in the design of federally built or supported data banks.

6. Archival problems and uses be a required consideration in the design of future monitoring programs.

7. High priority be given to the development of data bank directories and inventories of data sources.

8. Initiate a study to determine how to improve secondary literature covered in the field of pollution.

The SEQUIP Committee felt that much information about pollution appeared in secondary journals relating to other disciplines such as chemistry, physics, oceanography and climatology.

B.4.2.5 Solid Waste

1. Expand the resources in the SOLID WASTE INFORMATION RETRIEVAL SYSTEM of EPA.

2. Greater emphasis be placed on social and behavioral science aspects of the solid waste problem.

3. Establish centers for analysis, evaluation and consolidation of diverse data in the solid waste field.

Professionals at these centers would devote part time to these activities.

B.4.2.6 Radiation

The multiplicity of data sources (e.g. AEC, Federal Radiation Council, Bureau of Radiological Health) is considered to be a healthy situation by the committee. They recommend strengthening the supported programs and promote intercommunication among them.

B.4.2.7 Agricultural Chemicals

1. A clearing house for pesticide information be formally established in the TOXICOLOGY information programs of the National Library of Medicine.

2. Programs on the long term effects of pollutants on man should adopt the approach of the pesticide committee within EPA which emphasize epidemiological research.

APPENDIX 5

COMPATIBILITY ASPECTS OF MONITORING DATA ACQUISITION

A.5.1 INTRODUCTION

Considering the variety of subjects and the extent of complex interactions which comprise the environment, it is understandable why so many governmental agencies representing various disciplines are concerned with one form or another of environmental monitoring. This diversity of monitoring systems is advantageous in that it implies that many points of view are being considered. On the other hand, such diversity can lead to confusion, duplication of effort, and non-uniformity of equipment, procedures, data, etc. Unfortunately many of the existing monitoring systems evolved with somewhat limited objectives in mind and an overall management system is needed to establish a degree of compatibility and a sense of cohesiveness.

It should be noted that for purposes of this paper on compatibility, two important assumptions have been made:

1) Accurate and valid data are being provided to the system - further discussion of this topic appears in paper No. 6.

2) Standard methods and instrumentation are in use - paper No. 3 contains further discussion of this topic.

A.5.2 SOURCES OF DATA

There are many sources of environmental data inside and outside of EPA with the portion of overall monitoring performed by EPA itself being rather small. A listing of such sources would include:

a) EPA
b) other federal agencies

c) state agencies
d) local agencies
e) industries
f) universities
g) private research companies
h) international organizations
i) interstate commissions

An initial step in eliminating incompatibilities and duplication in a nationwide environmental network is to determine who is gathering what kinds of data. At present the National Referral Center (NRC) in the Library of Congress has the task of directing inquirers; particularly those from outside federal agencies, to locations within the federal government which might supply various forms of environmental data. In many cases the NRC has information relating to the published output of a particular agency but not the types of raw data that may be involved. An effort should be made to ensure that NRC's referral banks are up-to-date and as complete as possible. Once the primary federal source of a particular kind of data has been identified by NRC, it should be that federal agency's responsibility to be aware of state, local, industrial, etc. sources of the same and related data.

An alternative approach would be to have the responsibility for knowing about all sources of environmental information lie within the Office of Monitoring (OM) in EPA. Except for the added expense, it would seem to be advantageous for OM to have this capability. For each type of monitoring network OM could have files similar to the information contained in the Smithsonian directory*.

A.5.3 USERS OF DATA

The list of users of data reads very much like the one for sources of data. The important point is that the monitoring system must be responsive to EPA headquarters and regional offices as well as state and local agencies. The overall coordinated network has to be sold on the basis of the services to be provided to all of the user groups.

A.5.4 TYPES OF DATA

In order to assess compatibility requirements for environmental data, it is necessary to determine the scope of the data to be considered which would include:

- a) source and emissions
- b) environmental, or ambient conditions
- c) effects
  - i) human health
  - ii) other biological
  - iii) materials
  - iv) environmental (e.g. weather modification and critical pathways)
- d) economic
  - i) impact of various actions
  - ii) cost of pollution control
  - iii) sales of pollutants (e.g. pesticides)

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* National and International Environmental Monitoring Activities - A Directory, Smithsonian Institution (Oct. 1970)

- e) industrial studies
    - i) control processes
    - ii) materials balance
    - III) plant productivity
- f) meteorological
- g) demographic
- h) miscellaneous
    - i) instrument methodology
    - ii) distribution of pollutants (e.g. pesticides)

A.5.5 USES OF DATA

The data to be collected will serve many purposes at the federal, state and local levels as well as for non-governmental groups. Some of these uses are outlined below:

- a) enforcement activities
- b) standard setting
- c) establish baselines
- d) environmental quality assessment
- e) impact evaluation
- f) scientific research
- g) trend analysis
- h) planning and management

The last item (h) is of particular interest in terms of future monitoring needs with respect to:

- i) land use as affected by air, water, and solid waste pollution activities
- ii) transportation programs

iii) facilities construction

iv) urban management

Another use which has future implications is that of modeling for predictive purposes with regard to:

i) impact of pollution from land development

ii) impact of a point source accident

iii) types and extent of necessary control techniques

iv) whom to shut down in the event of an episode - under differing topographic and meteorological conditions the same type of source may not be the most responsible emitter for different locations and times.

A.5.6 INFORMATION COORDINATION AND DISTRIBUTION

There has to be an overall management system responsible for the dissemination of information; not necessarily all of it, but at least that which permits the users to know what data is available and how it can be used. Part of this program would involve a system for the routine distribution of recently archived information on a monthly or quarterly basis according to:

a) pollutant type

b) potential user

c) time of collection

d) geographical area

e) population density

Moreover, every six or twelve months there should be a complete updating of the information inventory.

Because of the commonality of missions, it would be logical and desirable to have a strong interfacing with the Technology Transfer Program already in existence.

A.5.7 DATA GATHERING

A.5.7.1 Siting

The selection of sampling locations (siting) depends on the specific objectives to be met as outlined above "Uses of Data". The selection of a monitoring site is also a function of the parameter of primary concern. For instance, when monitoring a particular effluent source in a river, a station immediately below the mixing zone is best suited for temperature data. On the other hand, the best location to measure dissolved oxygen or bacterial levels may be farther away from the source where more complete mixing has occurred. All well and good if these sites monitor the parameter(s) for which they were designed. Often, however, practical constraints dictate that a site designed or located for one purpose (or parameter) also monitor for others. Incompatibilities arise when trying to compare or aggregate data from say, a site well located to monitor dissolved oxygen along with similar data from a site not so designed.

A.5.7.2 Sensors

With regard to sensing devices an obvious requirement is that the sensor and its attendant recording equipment be mechanically and/or electronically compatible. With regard to data requirements when using sensors of the same design and make, the only problem is to make certain that they are calibrated to the same reference standards.

Monitoring for a given parameter using sensors based on different designs or analytical techniques requires intercalibration to ensure comparability and proper interpretability of the results. The concept of such calibration measures is covered in paper 3.

A.5.8 SOFTWARE SYSTEMS

Software systems are those programs and instructions involved in the processing, storage, and retrieval aspects of data handling. Probably the most important of these phases is that of the processing of data (sometimes referred to as preprocessing). It is reasonable to assume that the programmer who originally processes the data does so in a manner consistent with his own immediate needs. After this the data will be stored. The compatibility of storage really has meaning when someone else tries to retrieve the data for purposes other than its original use. If the original programmer has formatted the data and employed programs according to a consistent set of EPA guidelines then subsequent users should have little difficulty in retrieving it for their own purposes. In other words, when producing information, one should strive for a degree of commonality of output because someone else may need the data as their input.

Compatibility in the processing of data will be understood with regard to those functions necessary to get the raw data from the sensor into a form suitable for computer input. The availability of data in a clearly defined and well documented format is the basis of an effective processing system. All too often data are recorded in a format that is complicated, confused, incomplete, and insufficiently documented.

When such data leave the immediate care of the person responsible for recording them, their utility is effectively lost. Selection of a format need not constrain an agency in any way, particularly if data are recorded in machine-readable form, since the data can then be reproduced with very little difficulty into a variety of forms and formats. For example, an agency could use one format for certain internal records and another format (such as SAROAD*) for interchange of data with other agencies both within and outside EPA.

Most processing of data will require that data be machine-readable, either on cards or magnetic tape. If certain monitoring groups can not afford this, their data can be sent in on forms, and converted in the most effective manner. The directions for filling out such forms should be kept as simple as possible and examples of how to complete the forms are advisable.

Certain types of information are fundamental to most pollution monitoring and are typified by the following SAROAD checklist of data requirements:

a) Site identification form

b) Pollutants measured

c) Sampling methods (e.g. Saltzman, West Gaeke)

d) Instruments

e) Units in which the measurements are expressed

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* SAROAD Users Manual, Office of Air Programs, EPA, Research Triangle Part, N. C. (July 1971).

f) Decimal point location

g) Date of reading

h) Time of reading

i) Sampling frequency

j) Averaging time (duration of sample)

k) Identification of any special codes

l) Special instructions to persons using data

Although the above list was designed specifically for the monitoring of ambient air pollution, many of the items apply to other areas of pollution as well. Certainly for those elements which are common to several programs, EPA should establish agency-wide guidelines for common reporting practices. These guidelines should also address the proper form for items which are unique to a monitoring program in a particular office.

The following is a list of items, in addition to the above listing of data requirements, which will facilitate conversions from one system to another:

Punched Cards

a) Identification of any unusual formats, characters, or punching.

b) Sequence of data cards (e.g., sort sequence, ordering, arrangement).

c) Identification of machine on which cards were generated.

Magnetic Tape

d) Record length (in number of characters)

e) Record type (fixed or variable length)

f) Blocking factor (in number of records/block)

g) Description of file contents

- indicate parameters observed
- number of sites reported
- years spanned
- approximate number of records

h) Description of file format (record layout)

- indicate format identification numbers used and observation time intervals

i) Description of file sort sequence

- identify individual fields
- indicate major to minor ordering
- for each field indicate whether ascending or descending

Software systems already exist in the air, water, radiation, pesticide, and solid waste programs and in many instances only minor modifications would be necessary to make them compatible with one another instead of developing completely new software. To insure this compatibility, a permanent working group should be established comprised of representatives from the private sector and government (non-EPA, EDA headquarters, regions, with particular emphasis on the media and categories offices)

HARDWARE SYSTEMS

There seems to be a lack of cooperation among computer manufacturers in terms of data and programs from one machine being acceptable to another. Even within the same company incompatabilities exist depending upon whether a second or third generation machine is being used. Some of these incompatibilities with regard to magnetic tape presentation are associated with the following items:

a) Reel identification
b) File number
c) Recording density (556, 800, or 1600)
d) Number of tracks (7 or 9)
e) Parity (odd or even)
f) Recording code (ASCII or EBCDIC)

The software problems can often be resolved by programmers at the data processing center. Even so, correction of such incompatibilities is time consuming and should be kept at a minimum. The hardware problems can be solved with clever programming in conjunction with the necessary conversion hardware. Since not all computer centers are so equipped, perhaps one computing facility in each region could be equipped and designated to handle such chores. The problem of hardware compatibility is currently being studied by the Office of Data Analysis in EPA.

A.5.9 COMMONALITY OF LANGUAGE AND UNITS

At the present time there exists no dictionary, glossary, or thesaurus of terms used in the overall environmental field. This is largely because environmental quality is not a formal scientific discipline, but a label given to a variety of activities that cut across the normal boundaries of science. Moreover, in many areas, problems require not only technical data but also economic, legal, political and social data.

The problem of terminology inconsistency is compounded when exchanging information with foreign institutions: Given the global nature of environmental pollution, such exchanges will become increasingly important. Already, many countries have made considerable contributions to our knowledge (e.g. Sweden, Japan). An excellent service is provided by the Water Pollution Research Board of Great Britain with its monthly issues of Water Pollution Abstracts.

Even within a single discipline there are differences as to the use of various terms. A notable example is in the field of chemistry and the use of several names for the same compound (i.e., methanethiol vs. methyl mercaptan). The Chemical Abstract Service Registry System has identified and coded some 1.5 million compounds (about 250,000 additions annually) and this program should be promoted on a widescale basis.

It is recommended that a dictionary of users terms be developed on an EPA-wide basis. A "standard" for air does not necessarily have the same meaning as for water. The word "ambient" has a different conotation to the noise pollution expert than is generally accepted. As a final example, consider the confusion between "monitoring" and "surveillance".

The diversity of units of measurement in use by different disciplines and organizations can lead to confusion and misinterpretation. Concentrations in water may be expressed in terms of ppm, milligrams/liter, milliequivalents/liter, molarity, normality, or percent by weight or volume, etc. Conversion from one set of units to another is generally a simple (but time consuming) formality involving multiplying by some factor. In some cases, however, conversion can be a nuisance. Some conversions require auxilliary information (e.g. ppm to ug/m needs temperature and pressure data to be done correctly) which may or may not be available. If it is not available, it might be neglected or assumed which can lead to the introduction of errors.

Another problem concerns the use of the British vs. metric system of units. To decide to convert to the metric system at this relatively early stage in environmental monitoring might make sense in light of a) facility of exchange with most foreign institutions, and b) the fact that this country itself may eventually go metric and later more intense confusion would be averted. A year ago the Office of Air Programs suggested a plan for adopting the metric system and phasing out British units and especially mixed units. Judging by the fact that recent legislation on automobile emissions was based on grams of pollutant per vehicle mile, a redoubled effort on an EPA-wide basis is necessary. This transition was highly recommended by the Las Vegas Conference. The transition should occur gradually to allow personnel to become accustomed to the new system and for equipment modifications to be made.

Often there is a tendency for, say, state agencies to use their own terminology even when filling out federal forms. A rather extreme example concerns a certain state which uses its own state oriented latitude/longitude system in completing SAROAD forms.

With regard to site locations it should be noted that about an order of magnitude of precision is gained by using the Universal Transverse Mercator (UTM) system as opposed to the usual latitude and longitude reading. It might be desirable to incorporate UTM, with appropriate means for cross conversion, into the coding system for monitoring sites. A more common incompatibility occurs when states use their own pollutant and/or site location code numbers. In the area of water quality the STORET system is trying to unravel the problem of listing of site locations either by "rivermile" or latitude vs. longitude.

A.5.10 DEMONSTRATION OF SYSTEM

In order to sell the idea of a coordinated overall system for the management of environmental information, it would be desirable to provide a demonstration. This would be a study exercise showing how various users can get their particular type of information from the system as well as how such data enter the system. This would involve the network design and could be performed from the point of view of users such as those involved with:

a) regional administration

b) legal action

c) decision/policy making

d) scientific research

e) control implementation

5.11 ENFORCEMENT

For a program of compatibility to be effective for all users, all sources of data will have to comply. Executive orders can be used to provide compliance among the various federal agencies. Through the mechanism of issuing of research and construction grants, state and local agencies can be encouraged to comply with compatibility guidelines. Furthermore, federal approval of their implementation plans could be based in part on their cooperation in this matter. Compliance from the private sector, principally industries, will be on a more or less voluntary basis with the possibility of some pressure being applied through the permit program for effluent discharges. The national standards for atmospheric emissions may be useful in this respect as well.

APPENDIX 6

QUALITY CONTROL ASPECTS OF MONITORING DATA ACQUISITION

A.6.1 INTRODUCTION

Quality control implies the maintenance of certain prescribed standards of performance or output. Various techniques and models may be employed to assure that quality is deisgned into a system and/or may be regained if the system should deviate unacceptably from its expected performance. It is sometimes difficult to separate the functions of standardization and quality control. In these papers the former will concern itself primarily with the design and setting of specifications for equipment and procedures (see Appendix 3) while the latter involves assuring the quality and reliability of data produced as a result of these procedures. Quality control, then, provides for the implementation and continued integrity of standardization. Even within these guidelines there is some degree of interplay and feedback which makes overlap inevitable.

With regard to the paragraphs below, it should be borne in mind that the comments apply not only to monitoring functions "within" EPA (including states and regions) but also to contributing groups outside of EPA such as universities, industries, and other federal agencies. Within the realm of environmental monitoring there are several areas where quality control may be applied such as personnel, equipment, data, and procedures. It should be noted that quality control applies not only to these component aspects by themselves but also to their interrelationships and functioning as a whole system. The following is a proposed outline of functions to be performed by an integrated approach to quality control.

A.6.2 DEFINITION OF GOALS AND OBJECTIVES OF A MONITORING PROGRAM

The degree to which quality control is to be applied throughout a program will depend upon the end uses of the data. Therefore, the first step is to define the goals and objectives of a program which, when taken in light of those from other programs, helps establish the bounds of the quality control effort.

A.6.3 GUIDELINES FOR ESTABLISHING A MONITORING NETWORK

In the setting up of a monitoring network quality control plays an important part in the implementation of and assuring the adherence to guidelines in the following areas:

a) Site location - whether a site is chosen on a random basis, as part of a grid, a combination of these two ideas, or specifically for a stated purpose depends upon the use of the data and the parameter(s) measured. Quality control relates to siting in that it is necessary to periodically review siting criteria in light of changing legislation, population and industrial shifts, technological advances in monitoring equipment, etc. Adjacent construction projects could require the relocation of a given site.

b) Type of station - data requirements dictate whether a station should monitor continuously, gather information integrated over a specific time period, or provide grab samples to be analysed in the lab. Are the procedural specifications being adhered to? For instance, in the case of grab samples, are the samples taken from the same location every time, same time of day, etc.?

c) Selection of instrumentation and methods - instrumentation and methods needs will change as the state-of-the-art progresses and quality control should see that these changes are incorporated.

d) Averaging time to be consistent with standards - if regulations require, say, an 8 hour sampling period, quality control should see to it that this time period is not violated beyond certain tolerances.

e) Sampling frequency - in the case of annual averages of SO_2, adequate coverage may be maintained with intermittent sampling at frequencies calculated statistically for desired levels of precision and related to the degree of pollution. Quality control might suggest a different sampling frequency if the ambient conditions changed significantly.

f) Instrument maintenance and calibration - with regard to a particular piece of equipment once the desired accuracy, precision, sensitivity, and range have been specified, it is the job of the quality control program to insure that these attributes be maintained throughout its operation. The initial calibration and subsequent recalibrations should be performed according to a schedule deemed necessary for a particular piece of equipment. Obviously there will be unscheduled malfunctions and repairs requiring recalibration.

Quality control should have the responsibility for approving manuals for maintenance and calibration and updating the texts of "standard methods."

The dependability of a piece of equipment will be taken not in terms, necessarily, of its accuracy, but rather with regard to its amount of operational time vis à vis the time it is inoperable due to some breakdown. A certain amount of downtime is to be expected for routine preventive maintenance and proper scheduling can insure an uninterrupted flow of data; i.e., nighttime maintenance for pollutants which are most serious during the day or borrowing standby equipment.

However, unscheduled downtime can result in data gaps which may impair analysis and interpretation. In order to better understand and minimize such breakdowns, careful maintenance logs should be kept indicating such items as type of failure, probable cause, time, date, frequency of malfunction, ease of repair, etc.

With regard to the proper functioning of equipment there are certain external conditions whose quality should be maintained. These include air conditioning for temperature - sensitive equipment, constant line voltage, insurance against power outages or brownouts especially during critical episodes, special shielding, insulation, or isolation of the housing for equipment, and the use of high quality laboratory chemicals and reagents.

g) Questionnaires and surveys - In the case of such areas as solid waste management and epidemiological studies where data are derived mainly from questionnaires and surveys rather than physical measurements or chemical analysis, quality control implies adherence to reliable polling methods and survey techniques and proper statistical analyses and interpretation of results.

A.6.4 TRAINING

The effectiveness of the most carefully designed equipment and procedures can be seriously reduced in the hands of unqualified personnel who are not capable nor properly motivated. Providing good job descriptions is a necessary step for weeding out unqualified applicants. Educational programs are then promoted to communicate skills, methods, ideas, objectives, and attitudes. In order to measure an employee's knowledge and determine what training is needed, a series of test questions can be designed to be answered by employees in specific areas.

Such training can take place on two levels:

a) Formal training - in the classroom or at seminars where theory and lab applications are taught primarily from the textbook with some supplemental laboratory work.

b) On-the-job-training - in an EPA or accredited state laboratory with an emphasis on the practical aspects of monitoring.

It may be desirable to provide a program of requalification. This may be necessary when a person's performance (competence and attitude) seem to be waning. Moreover, changing demands (new equipment, procedures, regulations) often alter requirements of skill and knowledge and increase training needs. Not only does proper training enhance the quality of the data, but it also helps to cut down on the damage and abuse of instruments.

A.6.5 LABORATORY CERTIFICATION

To ensure comparability of data, a uniform degree of excellence should be expected from the various governmental and private laboratories providing input to EPA monitoring activities. A certification program with periodic reviews, while not an absolute guarantee of excellence, is a necessity towards establishing a common denominator of quality with regard to:

a) Compentency of personnel
b) Adequacy of facilities
c) Use of proper analytical methods
d) Uniformity of data handling procedures

Because of resource limitations, it would not be feasible for EPA headquarters to provide the overall nationwide quality control measures in terms of funding and manpower. EPA could implement the program by providing guidance, regulations, and standards to the ten regions which in turn would have similar responsibility toward the states. The states then would be the driving force behind the local agencies.

A useful technique, the so-called round-robin method, for laboratory testing should be implemented on a widespread basis. This involves the preparation of a known sample, splitting it into many "identical" parts, and sending them to various laboratories for analysis. Again, the chain-of-command would be in effect - regions to states to local. If the results of a particular analysis do not fall within a prescribed range, the regions or states can investigate further.

A.6.6 CALIBRATION STANDARDS

The quality control program should insure that reference standards for calibration, developed to EPA's specifications, are certified by the National Bureau of Standards. NBS has had a great deal of experience in such matters and their reputation is excellent. For EPA to enforce standards which it certified itself would present a conflict-of-interest situation in legal actions.

Calibration techniques and degree may differ for a particular type of equipment depending upon whether it is designed for use in the field or in the laboratory. For field instruments calibration can take place either on-site or at some central laboratory. For the former there is less downtime involved (if necessary tools are readily available) and less chance of damage in transit. On the other hand, more sophisticated calibration equipment and better trained personnel are generally available at a central lab where calibration is a major function. The decision should be based upon such factors as the fragility of equipment, availability of on-site redundant monitoring, and the degree of calibration required.

The question of calibration has special significance during an episode, or emergency condition. For instance, during an air pollution episode, there are several stages of increasing severity where different kinds of pollutant emitters may be required to curtail or shut down their operations. Since these shutdowns can be very costly to a company, they should be based on the best of information. A false alarm could result in a lawsuit being brought against the EPA. Given the fact that air pollution episodes are somewhat predictable because certain meteorological conditions must prevail, there is time for emergency recalibrations to be made on site by special federal teams or by qualified local personnel.

Calibration standards are necessary in order to make interlaboratory calibrations using collaborative, or round-robin, testing. This may be the preferred method for assuring international cooperation of certain countries where EPA field teams may not be invited due to diplomatic considerations.

A.6.7 EPA FIELD TEAMS

In addition to mailing similar samples to different labs for corroborative testing, it is desirable to have field teams of highly trained experts visit the various labs on a periodic and/or random basis. Since the number of these teams is small, they may be limited to providing interregional and interagency calibrations only. Similar teams could be established by the states, and trained by EPA, to satisfy their own needs. Since the experience and exchange of techniques and information would be valuable, the EPA field teams would be sent to foreign labs on request of the host country.

EPA field teams would be able to perform dynamic calibrations (DC) on instruments where it is desirable not to shut down the equipment and this feature (DC) is not inherent to the equipment. This situation might occur during the air pollution episodes mentioned earlier.

A.6.8 DATA HANDLING AND VERIFICATION

Although this topic is discussed elsewhere (see Appendix 5), a few remarks are in order here.

Proper validation and editing procedures should be defined and maintained to insure quality control of data entering the data banks, regardless of source. This might require establishing special units to handle data obtained from sources outside EPA.

In the validation and verification of data, one must be able to discern whether a marked change in data values indicates a real change in the phenomenon or quantity being measured, an equipment or human error, or a set of random events. Various statistical methods are available which should help straighten out such problems. Another verification technique involves the use of redundant equipment or a completely different, but equally reliable, method. Spot checks on data using mobile laboratories are useful in this regard.

An important aspect of quality control related to data handling concerns the publication of data. Typographical errors or ambiguous sentences can impair any good results of the previous efforts. Competent editors with technical training can catch serious errors which may creep into this last stage of data formulation. However, in the event that errors from any part of the total data gathering process get through and are discovered, records of such discrepancies must be maintained in order that corrective action and follow-up may be accomplished.

GUIDELINE DOCUMENTS

In order to insure that all involved parties are operating with a high degree of common understanding, each of the categories and media should prepare quality control guideline documents with listings and explanations of standard or accepted methods of analysis, data handling procedures, calibration techniques, training programs, etc. An example of such a document was recently prepared by the Office of Water Programs entitled "Control of Chemical Analyses in Water Pollution Laboratories".

A.6.10 METHODOLOGIES, PROCEDURES, AND INSTRUMENTATION TO MEET FUTURE NEEDS

Present quality control measures are by and large based on retrospect. The quality control program should address possible future needs in terms of new or impending legislation, technical improvements in monitoring, population growth, pollution forecasts, and technological shifts (e.g. nuclear vs. fossil-fueled power or the production of a new class of chemicals).

The calibre of data from all sources should be of the same high calibre and mechanisms should be devised to assure compliance. While coordination of quality control programs may take time and require compromises among various governmental groups, adequate legislation could provide the impetus to do so. A more difficult problem arises when trying to enlist the cooperation of groups outside the government, such as universities and industries. Since much of a university's monitoring efforts may be supported by Federal funds, financial pressures can be brought forth. There may also be an incentive for a university to become a certified lab. Industry participation is on a more or less voluntary basis and providing for acceptable compliance could prove difficult. A workable method (e.g. penalties or incentives, working through trade associations, etc.) must be found - hopefully short of legislation. Private laboratories, which are performing more and more analytical work for states, locals, and industries, should logically be interested in obtaining official EPA certification since this would enhance the credibility of their data, especially in legal cases.

APPENDIX 7

MONITORING TECHNIQUES, IN-SITU & REMOTE

A.7.1 INTRODUCTION

A.7.1.1 Definitions

At the outset the terms of importance should be defined. Surveillance is that broad term that describes the detection of conditions and in the environmental field describes the detection of violations and is thus source oriented. Ambient monitoring is related to the quality of the environment and is more area and/or receptor oriented.

Active monitors are those monitors that emit energy and detect the energy reflected, refracted, etc. from the environment and/or pollutant. A passive monitor only detects properties of the environment and/or pollutant using other sources of energy, such as the sun, to illuminate the target.

Remote monitors may be active or passive and are those monitors which do not come in contact with the target of interest. In-situ monitors are in contact with the target of interest. Platforms, such as aircraft, boats, towers, buoys, satellites, etc., do not dictate the classification (remote, in-situ) of the monitor; this point is sometimes overlooked and causes confusion.

Finally, there are in-situ monitors that may have remote data links such as telemetry for instance. The nature of the communication link also does not specify the classification of the monitor.

A.7.1.2 Overview Remarks

At the outset of this paper, some recognition and perspective of remote monitoring techniques is called for. Such techniques offer the opportunity for establishing broad trends, indicate situations requiring early warning, and an aid when near real time information is desirable. However, remote monitoring techniques require combinational use with ground truth measurements in order to be used effectively. EPA's present activities rely heavily upon in-situ monitoring. The planning and coordination of remote monitoring R&D, however, for future use in EPA will be continued. Some of the remote techniques now being developed at the Western Environmental Research Laboratory (WERL) will be phased into operational use as they prove to be useful.

The body of this paper (section A.7.3) is devoted to the state of the art in monitoring. Present and future in-situ monitoring is covered (capabilities and limitations) in Sections A.7.3 and Attachments B.7.1 and B.7.2: Descriptions of some promising remote monitoring techniques are covered (capabilities and limitations) also in Section A.7.3 and in Attachments B.7.3 and B.7.4.

There are many limitations in both types of monitoring techniques at the present time. Accuracy, reliability of both air and water quality in-situ techniques demands that further improvements be made. The use of automated in-situ monitors with remote and wire data links to computer data banks is another area in which EPA personnel are discovering that numerous difficulties and pitfalls requiring continual re-evaluation and improvement. There are need for operational devices not fulfilled by any class of monitor. One of these is the ion probe operable in a salt water media. Another is for a quick response BOD monitor. Throughout this paper, the designation of use (research stage, development stage, test and evaluation stage, colloborative stage, promulgation stage) is presented as the status of development of each monitor. The specific capabilities and limitations (attributes) are described where possible. The promulgated technique is the only technique which may be legally defensible.

Considerable effort will be required to screen, prioritize and oversee the development effort. A coordinated program is a necessity. The research efforts required for the development of standard monitoring techniques and data management will require a continual review by the Office of Monitoring to see that each new technique has the proper precision, reliability, compatibility, etc., built into the system and that the standard method (promulgated stage) is developed for each. The workshop on monitoring techniques, scheduled for early December 1971 will be the initial step in this direction. The workshop will be a planning session designed to stimulate meaningful technical exchanges on the needs of monitoring, particularly the needs of the near future. The workshop will stress the use of hard, realistic state of the art systems for the near future EPA monitoring system.

Future activities of the Office of Monitoring will include the determination of the (1) accessibility of classified monitoring techniques-methods, monitors and platforms - from other agencies, (2) the possible accommodation of other Federal monitoring programs to the specific needs of EPA, and (3) the development of means of informing Surveillance and Analysis Division personnel on useful remote monitoring techniques when they emerge. The complete gamut - the proper monitoring technique use, the data management (data handling, processing, analysis and dissemination) requirements, the monitoring technique maintenance and deployment - will be communicated.

A.7.1.3 Monitoring Techniques Panel Recommendations

The recommendations of the Monitoring Techniques Panel, WERL, October 14 - 16, 1971, are listed below. These recommendations are placed at this point of the paper in order to orient the reviewer to some present thinking of the Office of Monitoring and are in order of their priority.

1st - Continuation and augmentation of the Western Environmental Research Laboratory (WERL) activities. WERL will continue to perform an on-call airborne reconnaissance (in-situ and remote) for all ten Regional Offices of EPA. It is felt that a few Regional Surveillance and Analysis Division personnel should become trained as pilot-monitoring techniques technicians to aid in the use of newly developed methods. WERL will act as a center of excellence, that is, to aid in the development of the techniques in a lead way.

2nd - The Office of Monitoring should plan for the availability of light (excess military service) monitoring aircraft as augmentation of WERL activities or expansion of contract servi es now available (oil spill coverage).

3rd - The Office of Monitoring should analyse the economics and other advantages of a second center similar in capability to WERL for the east coast. It is not known at this juncture whether this will be the proper course of action.

4th - The assignment of research personnel to augment the staff of WERL. Such personnel would serve in the development of new monitoring techniques from research stage through the test and evaluation stage and perhaps through to the operation phase (after promulgation stage).

5th - The Office of Monitoring should aid in the development of an enhanced, centralized data processing and interpretation capability at WERL to serve the needs of all Regional Surveillance and Analysis Division personnel. This centralized service should be developed in parallel with the first priority.

A.7.2 ORGANIZATIONAL CONSIDERATIONS

Inherent in the development of an effective monitoring technique is the manner in which the system is designed, developed and administered. The objectives of overall monitoring system as a whole are:

a. To produce information on environmental levels, trends and patterns of components (solid, liquid or gaseous), trace metals and nonmetals in all urban and non-urban areas of the U. S.

b. To identify and to quantify of new or newly recognized pollutants.

c. Increase the basic understanding of the source-receptor relationships, pollutant interactions and decay processes.

d. To develop a bank of environmental data for use by Federal, State, local agencies and the general public.

Such a monitoring system requires interaction among the ten EPA Regional Offices, the Enforcement, Media and Categorical Offices of EPA; and the Office of Monitoring of EPA. EPA may request the assistance of other Federal, national and international organizations in the development of environmental monitors. Inputs from NASA, NOAA, DOD, etc., should be explored to see if their programs can be accommodated to the needs of EPA, in particular the satellite, aircraft, and ground and water based monitoring systems now being developed or in operational use.

The major responsibilities of the Office of Monitoring of EPA are:

a. Planning, developing, coordinating and evaluating EPA environmental quality monitoring programs.

b. Coordinating EPA efforts with other Federal, State and local bodies.

c. Establishing baselines for trend analysis standards, and standards compliance programs.

d. Devise the EPA monitoring strategy.

e. Assuring the use of newly developed techniques (monitors and methods) for the various monitoring networks.

f. Analyzing monitored data in an effective manner.

A.7.3 STATE-OF-THE-ART IN MONITORING TECHNIQUES

The integrated nationwide environmental monitoring program - short term and long term (discussed in the main body of the paper and Appendix 2) are constructed on the foundation of realizable techniques in the time framework selected. The systems tradeoffs and the optimum system depend fundamentally and to a large degree on the state-of-the-art of monitoring techniques. Data transmission and handling techniques today generally outstrip the capability in producing reliable, accurate monitoring techniques.

The remainder of Section A.7.3, presents some of the specific capabilities and limitations of remote and in-situ monitoring techniques.

A.7.3.1 Techniques for Air Pollution Monitoring

The development of the monitoring requirements and the analysis of all possible techniques to satisfy each requirement is the first and fundamental step in the design of the monitoring system. Such a requirements analysis has been performed by the Office of Air Programs with the support of the Esso Research & Development Company* in the time period covering fiscal years 1972 through 1977. Sixth-three tasks for monitor development and ninety four tasks for methods development were generated with the requirements in each of the areas of Use, Table A-7-1. Thirteen techniques were in the research stage, sixty-seven were in the development stage, forty-five in the test and evaluation stage, twenty-two in the collaborative test stage and ten were in the promulgation stage. These stages are defined in Attachment B.7.1. The amount of the effort to produce promulgated methods and monitors is large. The comprehension of the state-of-the-art in over one hundred and fifty areas covering five different Use areas (Ambient Air Quality, Emissions - Stationary, Emissions - Mobile, Meteorology, Effects) requires a considerable effort and resources. (Methods and monitors already promulgated were not included in Table A-7-1.) It is interesting to note that of the sixty three monitor development tasks, eleven are for remote monitors. More detailed data on the requirements analysis (ESSO) may be found in Attachment B.7.1.

A.7.3.1.1 Techniques for Air Pollutants, In-Situ Monitoring

Air pollutants can generally be referred to as particulates (either suspended or settled) and gases. Particulate matter below 20μ in

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*EPA Plan for Air Pollution Measurement Technique Development Fiscal Years 1972-1977, First Draft, July 1971, CPA 22-69-154.

TABLE A-7-1

AIR POLLUTION MONITORING TECHNIQUES - STATUS OF USE AS OF JULY 1972

		RESEARCH		DEVELOPMENT		TEST AND EVALUATION		COLLABORATIVE TESTS		PROMULGATION		TOTAL	
AMBIENT AIR QUALITY	S	3		10		5		4		1		23	
	M		3		6		6		4		7		26
SOURCE-STATIONARY	S	1		12		7		1		0		21	
	M		2		7		20		13		2		44
SOURCES - MOBILE	S	0		10		3		0		0		13	
	M		3		15		2		0		0		20
METEOR-OLOGY	S	0		4		0		0		0		4	
	M		0		0		0		0		0		0
EFFECTS	S	0		2		0		0		0		2	
	M		1		1		2		0		0		4
TOTAL		4	9	38	29	15	30	5	17	1	9	63	94

S - MONITORS

M - METHODS

Reference: Air Pollution Measurement Technique Development Fiscal Years 1972-1977, First Draft July 1971, CPA 22-69-154 diameter is considered suspended particulate (with special attention being paid to those below 0.1u and respirable fraction). Currently, the prime measurement approach for total suspended particulates is the high-volume sampler, which merely draws air past a filter, where the suspended particulate is captured. The filter is then analyzed gravimetrically. Analyses for metals, soluble ions, cations, anions, etc. are made by chemically analyzing portions of the filter paper. For the measurement of the respirable fraction, inertial devices are used. Various photometric devices, such as the nephelometer and Volz sunphotometer, are used for aerosol measurement. For measurements of gaseous pollutants, several general principles or techniques are used and are discussed in Attachment B.7.2.

The detailed designation of needs for in-situ sensors are given in Table A-7-1 and Attachment B.7.1. A condensation of status of in-situ monitoring techniques is shown in Table A-7-2.

A.7.3.1.2 Status of Remote Monitoring Techniques for Air Pollutants

Remote air pollution surveillance has several promising new techniques still in the research and/or early developmental stages. Included among the instrumentation proposed for detecting air pollutants are infrared sensors, derivative spectrometers, dispersive correlation spectrometers, lasers and assorted electro-optical techniques. In Table A-7-3, several of the remote techniques are described. The attributes, useful for air pollution monitoring, are shown and the Stage of Use indicated. All techniques discussed are far from operational but

TABLE A-7-2

SOME IN-SITU TECHNIQUES FOR AIR POLLUTION DETERMINATION

TECHNIQUE	ATTRIBUTES/FAULTS	STAGE OF USE (DEFINITIONS IN ATTACHMENT A.7.1)
Static Types		
Dustfall Jars	Static sampling method for total settleable particulates. Requires well equipped laboratory for analysis. Sensitive to temp, wind and humidity.	Operational stage
Sulfation plates and disks	Static sampling of oxides of sulphur, hydrogen sulfide and sulfuric acid.	Operational stage
Mechanized Types		
Hi-Vol	Integrated quantification of total suspended particulates and multiple specific pollutants. Detailed laboratory analysis required.	Operational stage
Gas samplers	Integrated quantifications of gases - SO_2, NO_2, ammonia, total oxidants, aldehydes, and other gases. Detailed laboratory required.	Operational stage
Spot tape sampler	Provides rough relative soiling index.	Operational stage

TABLE A-7-2 (Continued)

TECHNIQUE	ATTRIBUTES/FAULTS	STAGE OF USE (DEFINITIONS IN ATTACHMENT A.7.1)
Automatic Types		
Gas	Continuous analysis of a gas or group of related gases.	Operational stage
Automatic tape sampler	Continuous analysis of sorting rate.	Operational stage
Chemiluminescent instrument	Ozone detection instrument, also technique for oxides of nitrogen.	Development stage and/or Test and Evaluation Stage
Flame-luminescent method	Sulfur detection.	"
Gas-chromatograph	For simultaneous determination of CO, CH_4 and total hydrocarbons.	"
Gas-chromstograph	For measuring hydrogen sulfide and certain organic sulfides.	"
Atomic absorption method	Continuous measure of lead.	"
Piezoelectric instrument	Continuous measure of particulate concentration.	"
Specific - ion electrode method	Continuous measure of fluorides.	"

should be pursued for their intrinsic characteristic of providing remote areal depictions in a near real time fashion. Such techniques may prove useful in the surveillance but may not be satisfactory for enforcement purposes for enforcement may require only promulgated techniques. Further detail on these remote techniques is contained in Attachment B.7.3.

The information in Table A-7-3 and Attachment B.7.3 in no way covers the entire field of air pollution remote monitoring research but have been included to describe the th e remote techniques which appear to be achievable for operational use in the next decade.

A.7.3.2 Monitoring Techniques for Water Quality

The success of a water quality program depends in part on the effectiveness of the pollution monitoring. This fact together with a growing public concern regarding environmental quality, has provided an incentive for the development of monitoring techniques - monitors and methods. Progress has been made in recent years in the development of in-situ analytical techniques and continuous monitoring instrumentation. However, in view of the dimensions and dynamic nature of the aquatic environment there is a need for new instrumental approaches to the problem of surveillance and data acquisition to supplement existing techniques. This need is particularly evident when dealing with large water masses such as estuaries, lakes, and the oceans of the world.

A list of the water quality parameters of interest is shown in Table A-7-4. The accuracy of measurement desired for some nineteen of these parameters is shown in Table A-7-5. More definition of important

TABLE A-7-3

SAME REMOTE TECHNIQUES FOR AIR POLLUTION DETERMINATION

TECHNIQUE	ATTRIBUTES	STAGE OF USE (DEFINITIONS IN ATTACHMENT A.7.1)
LIDAR (light-radar)	(1) An active areal surveillance device for acrosals - particulates, precipitation, etc.	Development stage
LIDAR & Spectroscopy of Scattering farm pollutants	An active areal surveillance device for gaseous pollutants in the atmosphere.	Research stage
Correlation Interferometer - Spectrometer	A passive areal surveillance device for gaseous pollutants in the atmosphere.	Development stage
Derivative Spectrometer Techniques	A family of techniques capable of being used in active & passive areal surveillance devices for gaseous pollutants	Research stage
Stellar light extinction spectroscopy (STARTAP)	A passive technique for determining aerosols, particulates and molecular species in the atmosphere	Research stage

TABLE A-7-4

WATER PARAMETERS

OXYGEN DEMANDING WASTES

*BOD
TOC
MBAS
*Nitrates & Nitrites as N
*Phosphorus

INFECTIOUS AGENTS

Microbiological
*Coliform
*Fecal Coliform

PLANT NUTRIENTS

MBAS
*Nitrates & Nitrites as N
*Phosphorus

SYNTHETIC ORGANIC

Chemical Exotics and Pesticides
*Insecticides
*Herbicides
CCE
Oil and Grease

INORGANIC AND MINERAL SUBSTANCES

Aluminum
Ammonia as N
Antimony
Arsenic
Asbestos
Barium
Beryllium
Boron
*Cadmium
Chlorine
*Chromium (hexavalent)
Cobalt
Copper
Dissolved Oxygen
*Fluoride
Hardness as $CaCO_3$
Calcium
Magnesium
Molybdenum
Iron

INORGANIC AND MINERAL SUBSTANCES (Cont'd)

*Lead
Manganese
*Mercury
Nickel
*Nitrates & Nitrites as N
*Phosphorus
Selenium
Silver
Sulfate
Strontium
Tellurium
Thallium
Uranyl Ion
Vanadium
*Zinc
Cyanide
Tin

SEDIMENTS

*Turbidity
Total Residue
Filtrable Residue
Total Dissolved Solids
Hardness as $CaCO_3$

RADIOACTIVE MATERIALS

*Gross Beta
*Radium-226
*Strontium-90
Thorium
Uranium

VIII. Thermal

Effluent heat content or
temperature rise of effluent.

* Initial set of pollutants
to be monitored

TABLE A-7-5

PARAMETERS OF CURRENT INTEREST FOR WHICH MONITORS DO NOT EXIST[*]

	RANGES OF CONCENTRATION DESIRED mg/l			PRECISION DESIRABLE mg/l		
PARAMETER	L	M	H	L	M	H
Organic nitrogen	0-1	-	0-10	0.01	-	0.5
Ammonia nitrogen	0-1	-	0-10	0.01	-	0.5
Nitrate nitrogen	0-1	-	0-10	0.01	-	0.5
Nitrite nitrogen	0-0.1	-	0-2	0.01	-	0.1
Inorganic phosphorus	0-2	-	0-20	0.01	-	0.5
Organic phosphorus	0-2	-	0-20	0.01	-	0.5
COD	0-50	-	0-500	1	-	10
MBAS[**]	0-1	-	1-10	0.01	-	0.1
Acidity or alkalinity	0-250	-	0-1000	5	-	50
Hardness	0-250	-	0-1000	5	-	50
Sulfate	0-100	-	0-1000	2	-	20
Phenols	0-0.5	0-5	0-50	0.01	-	0.1
Calcium	0-100	-	0-1000	2	-	20
Cyanide	0-0.1	0-1.0	0-10	0.005	0.05	0.5
Manganese	0-0.5	-	0.5	0.01	-	0.1
Zinc	0-2	-	0-10	0.01	-	0.5
Sodium	0-100	0-500	0-5000	2	10	100
Potassium	0-10	0-100	0-1000	0.5	5	50
Copper	0-0.5	-	0-5.0	0.01	-	0.1

[**] Methylene blue active substances.

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[*] Green, R. S., Monitoring Water Quality for Pollution Control, presented at 12th Annual Analytical Instruments Division (AID) Symposium, Instrument Society of America, on May 11, 1966, at Houston, Texas.

NOTE: Since this paper was presented, developments have been made in monitors for nitrate, sulfate, sodium, potassium, and calcium.

parameters and their accuracy is needed. The in-situ monitoring techniques presently in operational use or under some degree of Use (see B.7.1 for the definition of the various degrees of Use) are displayed in digest form in Table A-7-6. The attribute of each technique is also presented. Reliability and quality control are not uniform.

Similarily, the remote water quality monitoring techniques under analysis by various organizations are presented in digest form in Tables A-7-7 and Table A-7-8. A more detailed discussion of the capabilities and limitations of these remote monitoring techniques are found in Attachment B.7.4 and Ref.* below.

While it is appreciated that these operational and/or developmental in-situ sensors listed in Table A-7-6 were in response to the needs of each Federal, State, municipal and industrial organizations, an up-to-date requirements analysis, which compares the needs with the state of the art of all monitoring techniques is suggested here. Such a requirements analysis should be repeated as often as possible in order to up-date and redirect the R&D efforts of EPA both in short term and long term demands for monitoring techniques whether in-situ or remote.

A.7.3.3 Monitoring Techniques for Noise

Noise is generally defined as "unwanted sound," but there is no generally accepted definition of sound pollution. Among the characteristics of sound that enter into its becoming noise are intensity, frequency, intermittency, inappropriateness, interference with the task of the hearer, unexpectedness and masking effect of other sounds. In

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*"Technological Assessment of Remote Sensing Systems for Water Pollution Control", University of Michigan Annual Report 035790-4-L; 30 April 1971.

TABLE A-7-6

IN-SITU MONITORING TECHNIQUES FOR WATER POLLUTION/QUALITY

Technique	Attributes and/or Pollutants	Stage of Use (Definitions in Attachment B.7.1)
For Laboratory Analysis		
Electrochemical Instruments	Universal monitors for pH, conductivity, dissolved oxygen (DO), redox potential, and various specific ions	Operational* Stage, equipment made by 11 manufacturers. Some still in research stage.
Light absorption or light scattering	Monitors for turbidity and particulate measurements	Operational* Stage, equipment made by 6 manufacturers
Automated colorimetric or titration analyser	Chemical analysis monitors, for laboratory or fixed-process installations	Undergoing vigorous Developmental Stage, six manufacturers.
-	Dissolved organic matter - semi-automated BOD analyser	Research & Development Stages, three manufacturers.
Automated wet chemical analyser	Dissolved organic matter - automated chemical oxygen demand, COD	Development stage, one manufacturer.
-	Dissolved organic matter - total carbon or total organic carbon, TO & TOC	Operational* Stage, five manufacturers
For Water Quality Surveillance		
-	Automatic integrated water quality stations, fixed and portable, parameters usually measured are temperature, pH, dissolved oxygen (DO), conductivity, redox potential, & turbidity. Additional parameters may include chlorides, fluorides sunlight intensity, water flow rate and direction, water stage height and meteorological parameters	Operational* Stage, various manufacturers

TABLE A-7-6 (Continued)

Technique	Attributes and/or Pollutants	Stage of Use (Definitions in Attachment B.7.1)
Specific ion electrodes	Automatic monitoring of flouride, chloride, copper, nitrate, sulfide, hardness, calcium and others	Developmental Stage, limitations due to interferences, unstable calibrations, & short service lifetimes.
Wet chemistry - colorimetric method	Automated continuous six parameter unit with data telemetry	Developmental Stage, several manufacturers.
-	Automatic determination of oxygen demand or dissolved carbonaceous matter	Developmental Stage
For Municipal Water & Sewage Analysis		
-	Automated process control instrumentation dissolved oxygen for aeration control, turbidity, sludge density, redox, residual chlorine, phosphate	Developmental Stage, nine manufacturers make various components.
For Industrial Waste Water Treatment & Effluent Monitoring		
-	Same as municipal, above	Same as municipal, above

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[*] Operational Stage means that the instrument is in operational use; the instrument may not have been through a promulgation stage as defined in Attachment B.7.1.

TABLE A-7-7

REMOTE MONITORING TECHNIQUES FOR WATER QUALITY

Technique	Attributes	Stage of Use (Definitions in Attachment B.7.1)
Multi band Cameras	Passive, visible and infrared imaging of coastal water radiance & color, wave refractions algae blooms, sedimentation and water luminence. Water currents, extent of biological communities, shoals, sea ice, effluent discharge patterns, sediment migration as well as land uses can be obtained.	Developmental Stage and Test & Evaluation Stage (NASA, USDA, USGS & DOD).
Multi-Spectral Line Scanners	Passive video type line imaging of heated effluents & oil slicks. IR scanners provide night surveillance capability.	Developmental Stage and Test & Evaluation Stage
Radiometers	Passive, microwave and IR non-imaging devices useful for oil spill reconnaissance, detection of sea ice, surface temperature and salinity.	Developmental Stage and Test & Evaluation Stage
Passive Microwave Imagers	Surface temperature, roughness and water-ice interface during inclement weather.	Developmental Stage
Scatterometer/ Altimeter	Active monitors-yield range (altimetry) and reflection properties of the nadir surface roughness.	Developmental Stage
Side Tracking Radar	Active day/night, all weather sensor for depiction of large scale land & sea surface features.	Developmental Stage

TABLE A-7-8

Remote Monitoring Technological Assessment for Some Water Parameters - Partial List

Ref: "Technological Assessment of Remote Sensing Systems for Water Pollution Control", University of Michigan Annual Report 035790-4-L, 30 April 1971.

Note: EPA contract with University of Michigan to look at remote approaches for temperature, pH, dissolved oxygen. BOD, total dissolved electrolyte, turbidity, color, hardness, alkalinity, chloride ions, coliform bacteria, sulfate ions, detergents, nitrates, ammonia, phosphates, pesticides, flouride, ions, trace elements, radioactivity, plankton, benthos, and surface films is underway. Final report on all parameters to be completed in January 1972 by University of Michigan. All parameters are not expected to the compatible with remote methods.

Parameter	Technique	Attributes	Stage of Use (Definition in Attachment B.7.1)
Water temperature	IR Imaging (scanners) and Non-Imaging (thermometers) Radiometers	Useful in detection of effluent discharges and discharge rates, water currents, river delta patterns, ground water discharges into surface waters. 1^o to 2^o C difference possible from aircraft altitudes and velocities.	Test and Evaluation Stage
Water temperature	Microwave radiometry	Useful in detection of above features. Surface temperatures are possible from satellite attitudes and relative velocities..	Test and Evaluation Stage
Turbidity and suspended solids	Narrow band photography	-	Development Stage
Turbidity and suspended solids	Multi-spectral scanners	-	Development Stage
Turbidity and suspended solids	Airborne lasers	-	Research Stage

TABLE A-7-8 (Continued)

Parameter	Technique	Attributes	Stage of Use (Definition in Attachment B.7.1)
Fluorescence	Fraunhofer Line Detector (FLD) and Rhodamine Dye	Useful in detection of chlorophyll, phenol, ligninsulfonates and oils. Method less affected by turbidity.	Test and Evaluation Stage
Fluorescence	Laser induced fluorescence and photomultiplier	Useful in detection of same features as FLD.	Research Stage
Oil	Multiband photography	Oil type and oil slick identification. Doubtful in identifying all types of oil.	Research Stage
Oil	Fraunhofer Line Discriminator with Fluoresing Dyes	Oil slicks dimensions.	Developmental Stage
Oil	Wide Range Image Spectrophotometer (WISP)	Detection of oil slicks and oil films. Doubtful use,in visible region, of detecting a wide range of oils and conditions.	Developmental Stage
Oil	Microwave Radiometry	Oil films and oil thickness appear feasible, water roughness affects measurement.	Research Stage
Oil	Radar	Detection of oil slicks at sea. Useful in penetrating fogs, clouds, darkness and ability to cover large areas. Research required on oil thickness type under various sea states.	Research and Developmental Stages

TABLE A-7-8 (Continued)

Parameter	Technique	Attributes	Stage of Use (Definition in Attachment B.7.1)
Oil	Barringer Correlation Spectrometer	Detects vapor or gases liberated from oil. Fish oils as well as diesel and lube oils detectable.	Test and Evaluation Stage
Oil	Infrared Mapper (8-14μm)	Oil slick extent and oil thickness appear feasible more research for thickness.	Test and Evaluation & Research Stages
Oil	Multi-spectral Analysis	Seventeen bands analysed from 0.32μm to 13.5μm. No one band provides sufficient oil information. UV imaging provides better areal extent of oil slick than IR imagery.	Test and Evaluation & Research Stages
Plankton	Analysis of back scattered light and fluorescence methods, i.e. FLD.	Detection of phytoplankton by measuring plant pigment (usually chlorophyll) affected by light intensity, nutrients, species of organism, cell size cell age.	Research Stage
Entrophication	Above techniques for plankton may prove to be useful - more parameters needed.	Devices used to measure phytoplankton may be useful for eutrophication. Multiple parameters must be measured - chlorophyll, suspended solids, color, and light penetration.	Research Stage
Phenol	Fluorescence measurement techniques (see above) and maybe Raman Spectroscopy	Detection of effluent from plastics, rubber, steel, petroleum, chemical and automotive industries often contain high concentration of phenol. UV absorption, IR absorption and colorimetric techniques are not applicable for remote sensing of phenol.	Research Stage

addition, culturally associated preferences of the hearer enter into judgments about noise. Thus, while many people would doubt agree that life is becoming noisier, few are able to suggest quantitative methods for characterizing the noisiness of their environment.

The effects of noise can be thought of in terms of a physiological-psychological dichotomy. The major physiological effect of exposure to loud sound is an impairment of hearing, either permanent or temporary. The temporary effect, measured as a temporary shift in hearing threshold, is similar to the phenomenon of not being able to see well in a darkened room after having entered from a well-lighted area. After long-term exposure to excessive noise levels, the threshold shift can become permanent, and the individual becomes "hard of hearing."

Other physiological effects are pain, alternations in respiration circulation, basal metabolic rate, and muscle tension.[1] Many of these are doubtless coupled to psychological effects such as nervousness, anxiety, increased irritability and insomnia. Yet other psychological effects are related to the aesthetic qualities of sound. Indeed, as sounds are added to a quiet environment, the distinction between noise and acceptable sound is likely to be made on aesthetic grounds. Thus, a baby crying in the next apartment or a dog barking across the street will probably be considered disturbing noise, while the profusion of bird, cricket and other animal calls at dusk would be welcomed by many people.

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[1] Breyssee, Peter A., "Sound Pollution - Another Urban Problem," The Science Teacher, April 1970, pages 29-34.

With so many types of attributes, some quantifiable, others so dependent on cultural and personally variable standards and responses, an all-inclusive index of noise and sound quality of the environment is indeed an elusive goal. One method for calculating an index on the basis of average or reasonable life styles is described in the reference below.[1] The approach is quite general and adaptable to change in emphasis. The specific exposure values and limits, while based on information from the technical literature, are not rigidly prescribed and can be adjusted to conform to expert consensus without invalidating the overall approach. For further details on a new but within the state-of-the-art noise monitor see the reference below.

A.7.3.4 Monitoring Techniques for Radiation

Radioactivity can occur in air, land and water. However, this section deals only with those types of radiation which are capable of injuring man and/or his environment. These include alpha and beta particles, protons, neutrons, cosmic radiation, gamma rays, X-rays, and microwaves. Man is constantly exposed to radiation, both natural and man-made. Natural radiation derives from cosmic radiation and naturally radioactive substances in the earth and instructural materials. Man-made sources include weapons fallout, color TV sets, nuclear power plants, medical uses, kitchen appliances and radar hardware.

The situation regarding radioactive pollution is somewhat unique in that great foresight was involved at the dawn of the nuclear age in terms of strict legislation and a sense of moving forward with caution.

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[1] "Monitoring the Environment of the Nation," Appendix A-2 of the MITRE Report MTR 1660, April 1971, pages 91-106.

Extensive studies, monitoring, and data collection have been performed by the Atomic Energy Commission and branches of HEW for a number of years.

With regard to the overall annual radiation dose which the average man receives, by far the biggest contribution is that of naturally occurring background radiation (reference,* p. 7-28) for which he is not responsible and cannot reduce appreciably. Medical treatment, including dental, diagnostic, and therapeutic uses, accounts for a somewhat smaller amount with radioactive pollution also providing a relatively small portion.

Nevertheless, considering the trend toward installing more nuclear power plants (see Table A-7-9 for typical monitored indices and methods of analysis) and the still uncertain long-term and synergistic effects of radiation, it is necessary to maintain a strong monitoring capability in this area. The United States has good cooperation with Mexican and Canadian authorities with regard to their monitoring activities.

A.7.3.4.1 Monitoring Networks and Quantities/Substances Sampled.

Contained in Table A-7-10 are the names of a number of radiation monitoring networks. The monitoring techniques are contained in the four references listed on page 7-28.

Information on the monitors and methods has not been performed but it is believed that most networks have been built using AEC approved hardware and procedures.

A unified requirements analysis similar to the analysis for air pollution monitoring techniques should be considered.

TABLE A-7-9 TYPICAL ENVIRONMENTAL SURVEILLANCE PROGRAM FOR A NUCLEAR POWER PLANT

VECTORS OR INDICES	RELATIVE FREQUENCY OF SAMPLING	ANALYSIS	SAMPLING LOCATIONS
Air			
Particulate	High-Volume samples occasionally Low-Volume samples daily or weekly	Gross beta and gamma scans of filters and cartridges	Predominant downwind directions
Direct Radiation	Dosimeters changed every 28 days	Integrated dose by appropriate reader device	Predominant downwind directions
Water			
Surface water: receiving waters of the facility	Continuous, composite or weekly grab	Gross beta and gamma scans; periodic beta scintillation analysis for ^{3}H, with frequency a function of the levels measured	Stream above and below the facility; reservoir, bay, lake at nearest shoreline; any nearby domestic water suppliers using the receiving waters as a raw water source
Ground water	As applicable (usually quarterly or annually)	Gross beta and gamma scans	Supplies within 5 miles of the facility
Bottom sediments	Semiannually	Gross beta and gamma scans	Near reactor's outfall or above and below the outfall if the receiving water is a stream.
Aquatic biota	Variable	Gamma spectrum analysis for selected radionuclides	Near the reactor's outfall or above and below if receiving water is a stream
Terrestrial			
Soil	Annually	^{90}Sr and ^{137}Cs or gross beta	Prevailing downwind direction in nearest agricultural area
Milk	Monthly	Gamma spectrum analysis for ^{131}I	Dairy herds within 10 to 15 miles of the facility
	Quarterly composite	^{89}Sr and ^{90}Sr or total strontium by beta analysis	Dairy herds within 10 to 15 miles of the facility
Food crops and other vegetation	Seasonal (before or at harvesting time)	Gamma spectrum analysis	Within a 10 to 15 miles radius of the facility

TABLE A-7-10

Monitoring Networks & Quantities Sampled

Media or Category	Network or Agency	Sampled Quantities & Substances
AIR	Radiation Alert Network, APCO/EPA	TSP, gross α , gross β , plutonium,preprecipitation & tap water
	Health & Safety Network, AEC	Plutonium, other radionuclides
	International Atomic Energy Agency, IAEA	Hydrogen isotopes (deuterium & tritium and oxygen -18
	Some IQSY sites in U.S.	Cosmic radiation
	NOAA	Gamma radiation
WATER	Tritium Surveillance System	Surface water, precipitation monitoring, gross β , tap water
	Bureau of Commercial Fisheries	Radionuclides in estuaries and marine environment
	Geological Survey & Water Quality Office/ EPA	Radionuclides, gross α , gross β .
	Bureau of Radiological Health	Drinking water
LAND	Soil Conservation Service	Strontium 90
	Health & Safety Lab, AEC	All radioactive contaminants on land
EFFECTS - FOOD	Pasteurized Milk Network/EPA	Radiochemical analysis of milk, gamma scan " " "
	Institute of Total Diet/EPA	Monthly food and annual water sampled.
EFFECTS - HUMAN	Human Bone Network	--
	Alaskan Survey	Cesium - 137

A.7.3.5 Monitoring Techniques for Pesticides.

In order to trace and assess the movement of pesticides throughout the environment, it is necessary to measure residues in the physical media themselves, as well as in human and animal tissues. Programs for such measuring in soil, water, and air are discussed.

A.7.3.5.1 Soil

Soil is the natural receptacle for pesticides which are applied to crops; residues stored here can be carried into the atmosphere attached to particulates, and into the hydrosphere by runoff. It also is a source of pesticides for soil organisms which can concentrate them and which in turn serve as food for higher organisms (NPMP).[1] For example, Hunt found in 1965 that in DDT-sprayed elm environment, total pesticide residues (dry weight) accumulated from 9.9 ppm in soil to 140.6 ppm in earthworms to 443.9 ppm in adult robin brains (Hunt).[2]

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* "Radiation Biology," Allison P. Casarett, Prentice Hall (1968).

** "Radiation Surveillance Networks," WASH-1148, Robert E. Allen (Nov. 1969).

*** National and International Environmental Monitoring Activities--A Directory, Smithsonian Institution, (Oct. 1970).

**** "Modifications of Environmental Surveillance Network Operations," Bureau of Radiological Health (May 18, 1970).

[1] NPMP, National Pesticide Monitoring Program, Report of the Monitoring Panel, June, 1970.

[2] Hunt, Effects of Pesticides on Fish and Wildlife, U. S. Department of Interior, Fish and Wildlife Service, Circular 226, 1965.

The U. S. Department of Agriculture has in the past conducted a soil pesticide monitoring program which was part of the National Soil Monitoring Program, sponsored by the Federal Committee on Pest Control. This is now a part of the pesticide activities of EPA. The major objective of the program, as determined in 1968, has been to derive a reasonably reliable estimate of pesticide levels in United States soils with reference to land use. This includes:

1. determination of levels of pesticide residues in soils on major land-use areas and, through periodic samples, detection of changes in these levels;
2. determination of pesticide residue levels in crops grown on treated soils;
3. determination of pesticide residues in runoff water of certain agricultural lands;
4. determination of the concentration of certain pesticides at various depths in the soil.

Two major land uses were included--cropland and noncropland. Ten-acre sites were randomly selected at the rate of one site per 40,000 acres of cropland and one site per 400,000 acres of noncropland. That rate of sampling yielded 9,468 cropland sites and 3,822 noncropland sites (about 13,300 total). All soil samples were analyzed for chlorinated hydrocarbon insecticides and arsenic, and analyses for other pesticides were made on the basis of records of their use. Other determinations (crop levels, runoff water level, soil profile studies) were made at selected sites. The sampling schedule was planned to cycle in 4 years; i.e., one-fourth of the sites (3,325) were to be sampled each year.

When initiated in FY 1968, only 6 states were sampled. In FY 1969, cropland was sampled in 43 states and noncropland in 10 states. In FY 1970, cropland was sampled in 35 states. Because of lack of funds, the program had to be redirected in FY 1971, and only a small portion (corn and cotton belts) of the original monitoring efforts were continued. The Monitoring Panel of the National Pesticides Monitoring Program (NPMP) does not feel that under the reduced effort the objectives of the program can be met, and recommends adequate financing and full initiation of NPMP. Pesticides pose environmental problems of which we are probably only beginning to feel the effects and monitoring of these substances in soil, water, air, and tissue, is an area we cannot afford to neglect. Financing must be provided to bring the program up to standards the Monitoring Panel considers adequate, and then data obtained can be used in an index of changing residue levels. Monitoring of residues in soil organisms, particularly earthworms and beetles, and correlation of this data with soil residues, might also be useful.

A.7.3.5.2 Water

A national Monitoring Program for the Assessment of Pesticide Residues in the Hydrologic Environment has been designed in accordance with the objectives of the National Pesticides Monitoring Program of the Federal Committee on Pest Control, subsequently reorganized under the President's Cabinet Committee on the Environment. It represents a revision of an earlier program initiated in 1967 by the Federal Water Pollution Control Administration (now Water Quality Office) and the U. S. Geological Survey, and involves sampling of both water and bottom sediments. Water samples are to be collected four times a year, and sediment samples twice a year, from 161 sites chosen at random from hydrologic units within the 20 major drainage basins defined by the Water Resources Council. Under the plan, analysis will be made for the following chlorinated insecticides and herbicides:

ALDRIN
CHLORODANE
DDD
DDE
DDT
DIELDRIN
ENDRIN
HEPTACHLOR
HEPTACHLOR EPOXIDE
LINDANE
MALATHION
METHYL PARATHION
PARATHION
TOXAPHENE
2,4-D
2,4,5-T
SILVEX

High, median, and low pesticide levels for the major drainage areas will be reported in the Pesticides Monitoring Journal. Correlation of pesticide levels with other hydrologic data should be attempted.

A request has been made for funding of this program as part of the National Water Data Network implementation in the 1972 fiscal year by the U.S. Geological Survey under Bureau of the Budget Circular A-67 (NPMP). Once again, this is an area of crucial importance. As more and more toxic materials are being released into our environment, we must have some way of assessing the buildup of these materials, and correlating such buildup with levels in biota, as well as with geographical regions and sources. It is recommended that such funding indeed be carried through, and that data on these insecticides be correlated with data on residues in fresh-water fish.

A.7.3.5.3 Air

The atmosphere has been recognized as one of the major routes by which DDT is carried to the oceans and thus becomes widespread throughout the environment (SCEP).[1] The Monitoring Panel of the National Pesticides Monitoring Program has recommended that air sampling be conducted in a minimum of 40 to 60 separate areas of the country, with boundaries of these areas determined on an arbitrary basis, such as longitude-latitude, and with sampling sites within each area selected and operated according to a random design (NPMP). Monitoring of air over coastal regions might be particularly useful. Funding for such a program must be provided if an adequate picture of the spread of these substances in the environment is to be obtained. Such data, when obtained, could be used in an environmental index, and should also be correlated with that derived from other programs (soil, water, tissue residues).

Monitoring techniques for pesticides are more logically concerned with the methods used in the air and water media programs. Again it is suggested that a uniform review be performed of all involved agencies and a combined requirements analysis be performed. Automated techniques will be difficult to develop but should not be downgraded for that reason.

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[1] SCEP, Man's Impact on the Global Environment, Report of the Study on Critical Environmental Problems, sponsored by the Massachusetts Institute of Technology, 1970.

A.7.3.6 Monitoring Technique for Solid Waste

The days when communities could count on the ready availability of disposal sites for their solid wastes have nearly passed for many areas, and the problem will soon catch up with others. Open dumping is not only unaesthetic and hazardous to health (harborage and food source for insect and rodent pests, polluting of runoff water, pollution of air when burned, etc.), but land suitable for such outright destruction is becoming scarce. Even the more benign practice of sanitary landfill (area or trench methods) is said to require about one acre per 10,000 people per year.[1] As cities expand there is a very real shortage of new acreage available which is within economic hauling distance of the cities. Deep ravines have greater capacity, but their supply, too, is limited. While incinerators generally offer an efficient and hygienic means of disposing of combustible waste, they produce ash which must be hauled away and disposed of elsewhere, and if not outfitted with proper emission control devices, incinerators can contribute significantly to air pollution.

At the other side of the picture are the wastes being disposed of. Our technology, productive capacity, and inherent system of economic incentive encourage the disposal rather than the re-use of many items. Few are designed for degradability after their prescribed useful lives, since so many items are fabricated of relatively inert plastics, metals and glasses.

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[1] Benarde, Melvin A., "Our Precarious Habitat," W. W. Norton & Co. Inc., New York 1970, page 157.

Increased per capita consumption of materials also adds to the rate of growth of the solid waste problem. Degradable solid wastes can become especially troublesome when they are generated in too great concentrations for natural decomposition processes to assimilate them. On the other hand, large quantities of concentrated wastes have the potential value of permitting economies of scale when they are treated artificially, especially if there is a market for the end-product of the treatment.

Yet another dimension of the problem is the rising labor and capital costs associated with collection and disposal of solid waste. Trash collection and sanitation personnel demand and receive higher wages reflective of their increased status and critical importance in the scheme of community processes. More demanding treatment requirements and shortages in disposal sites are driving up the unit costs of solid waste management. The premium on extracting nonrenewable resources from the "waste stream" must surely increase. Thus, there are bound to be fundamental readjustments in solid waste management practices, just based on these conventional economic considerations alone.

Simple mass balance considerations suffice to illustrate that the amount of any type of waste discharged at the end of a waste stream is equal to the amount input to the system plus amounts generated within the system by conversion of other types (assumed negligible except for incinerator ash) less those amounts reclaimed from the waste stream for recycling or other re-use. The parameters chosen below to characterize solid waste issues are generally reflective of these input-output considerations and their associated costs.

A.7.3.6.1 Materials Balance Parameters

In a broad sense, the materials balance story of solid waste can be told by filling in the matrix of Table A-7-11. The source categories are intended to be complete as well as mutually exclusive, and likewise for the disposal categories. Each of these sets of categories is amenable to restructuring or other modification without changing the overall meaning of the parameters. The various cells of the matrix contain the amounts of solid waste from a given source (index = m) disposed in a particular way (index = n). The interesting measures of amount are weight Wmn, volume Vmn and, perhaps, combustion energy content Hmn. Weights expressed in tons or thousands of kilograms per year for municipalities, states, regions and industrial sectors should be adequate. Similarly, volumes, expressed in cubic meters per year or hectare-meters per year, are expressive of the amount of volume that solid wastes take up. Where the average energy content of the different sources of waste is a meaningful number, a rough indication of the energy picture can be assembled as well. It is anticipated that the "industrial" category would have to be subdivided into several constituent groups of similar materials before energy content figures would be meaningful. Units of energy content are kilocalories per kilogram, or, perhaps, kilowatt-hours per 1000 kilograms (metric ton).

For further details concerning the mass balance method for monitoring solid waste procedure, see reference below.[1] Monitors per se for solid

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[1] "Monitoring the Environment of the Nation." MITRE MTR 1660, April 1971. Appendix A-3, pages 149-160.

TABLE A-7-11

MATERIALS BALANCE AND COST PARAMETERS

DISPOSAL → (n) SOURCE (m) ↓											RECYCLING				
	UNMANAGED, UNCOLLECTED, SPREAD OR PILED ON GROUND		OPEN DUMP	OPEN BURNING	SANITARY LAND FILL	INCINERATION	PIT DISPOSAL	DEEP WELL INJECTION	DISPOSAL AT SEA	. . .	COMPOSTING	SALVATE OR REPROCESSING	. . .	. . .	TOTAL
RESIDENTIAL, COMMERCIAL & INSTITUTIONAL:															
COLLECTED															
UNCOLLECTED															
INDUSTRIAL															
MINING															
DEMOLITION WASTES															
ARCICULTURAL															
SEWAGE TREATMENT RESIDUE															
DEAD ANIMALS															
TOTAL															

WEIGHT Wmn
VOLUME Vmn
ENERGY CONTENT Hmn
COST OF COLLECTION CCmn
COST OF DISPOSAL CDmn

wastes are non-existent other than weight, volume, distance, and heat content devices or estimation procedures.

Networks for data gathering are discussed in the reference below along with suggested forms of data aggregation.

A.7.4 PLATFORMS FOR MONITORING TECHNIQUES

In order to obtain some initial remote and airborne in-situ sensing data it would be desirable to station a light aircraft in each of the ten EPA Regions equipped with a metric camera, IR Scanner and possibly other remote sensors. Such an instrumented platform would perform many useful functions, including qualitative monitoring of environmental parameters whenever contingency factors so required.

Where broader and systematic monitoring of environmental quality is desired, EPA Headquarters will assign larger and more fully instrumented aircraft which can acquire quantitative data and provide standard data products to each region. The Western Environmental Research Laboratory (WERL) is being considered as a facility which could provide these extended services in the Western United States. See Table A-7-12 for a digest of the capability of WERL.

At least one other such facility with aircraft capability will be necessary East of the Mississippi River. DOD, with its many aircraft already equipped with sophisticated sensors such as in-situ air property samples and remote monitoring techniques (side-looking radars, multiband cameras and multi-spectral scanners), could provide EPA with an interim capability for monitoring environmental degradation provided an agreement with the DOD can be arranged.

TABLE A-7-12

Digest of the Capabilities of the Western Environmental Research Laboratory of EPA

Note: Data listed below obtained via telecon with WERL representative, Nov. 21, 1971.

Aircraft on Hand

Two turbo-powered Beechcraft (modified C-45), one conventional C-45, one Navy trainer type (T-34) and one cargo aircraft (C-123). C-123 is suitable for conversion to a flying air, water and radiation analytical laboratory as well as a remote or mobile in-situ monitor. A ground vehicle outfitted for in-situ monitoring may be carried to sites by the C-123. Aircraft are being converted to take any array of monitors and backup instrumentation.

Instrumentation on Hand

Two 9" mapping cameras, four 70 mm Hasseblad cameras suitable for use with all forms of black and white, color and IR films and filters. Present data handling capability, for on-board aircraft use, consists of one seven channel recorder.

Aircraft to be Obtained in the Near Future

Two, and perhaps three, military excess reconnaissance aircraft (Mohawk), each with a side looking radar, IR scanner and three 50 mm cameras installed. Guidance, stable platform and intervalometer are also on board. One two-man helicopter for training purposes and two heavier helicopters (HUEY).

Other Instrumentation to be Obtained in the Near Future

One eleven channel Bendix line scanner, data acquisition system for on-board aircraft use (multichannel instrument recording,signal conditioning and computation capability suitable to interface with larger computer). Nuclear heads; SO_2, ozone and hydrocarbon in-situ monitors for airborne use; and other monitors as well as excess military photographic laboratory equipment expected shortly.

The Regional Offices should also be cognizant of the many remote monitoring projects already underway by NASA, USGS, USDA, NOAA, and DOD which are acquiring remote and in-situ monitored data. These include aircraft flights such as U-2, P-3, C-130 and RB57, and spacecraft programs such as Earth Resources Technology Satellite and Skylab. (See six references below).

Ref 1, Earth Resources Technology Satellite - General Electric Space Division, PIB-92 (4/71).

Ref 2, Earth Resources Technology Satellite, Ground Data Handling System, NASA Preliminary Description, PIB-A-61.

Ref 3, Aircraft Remote Sensing Systems, NASA/MSC - 04165, May 1971.

Ref 4, Skylab A-EREP Users Handbook, NASA/MSC, NASA-S-71-13209-F, March 1971.

Ref 5, Memorandum to ERSPRC from NASA, Earth Resources Technology Satellite Simulation Tests Areas with U-2 Aircraft.

Ref 6, "Surveying Earth Resources with Remote Sensors", J. T. Koutsandreas, Presented of IEEE, National Telemetering Conference, April 23, 1969.

In addition, NASA's Earth Observations Office will operate a Data Collection System (DCS) employing in-situ monitors which relay data to satellites for retransmittal to ground stations once the Earth Resources Technology Satellite is launched in March 1972.

ATTACHMENT B.7.1

Excerpts from the EPA Plan for Air Pollution Measurement Techniques Development, Fiscal Years 1972-1977.

Contained in this Attachment is a digest of the Air Pollution Control Offices recommended methods and monitors to be developed, Ref[*]. This digest consists of six charts covering the needs in the following functional areas, ambient, source-stationary, source-mobile, natural process-meteorology, and effects.

The stages of development of monitoring techniques, stages of Use, follow a fairly regular pattern which has been formalized for convenience in this paper as a series of five sequential stages as follows:

R = research; laboratory scale developments sufficient to demonstrate the applicability of a given principle of measurement, carried through the breadboard stage on synthetic samples or pure compounds.

D = development; carries through to the construction of a prototype instrument (or formalized procedure), based on an earlier lab-scale or breadboard model with enough data to determine exactly what is to be measured.

T&E = test and evaluation: commonly referred to as "debugging" this new monitor or method under typical operating conditions, so that it performs the measurement required with suitable modifications if necessary. The new technique is tested and sharpened in actual use, by operators other than those directly involved in its development, and usually in comparison with one or more alternate methods of analysis.

C = collaborative test; monitor and method are formalized and tested in simultaneous or parallel analyses by a body of experts and typical users who have not been directly concerned in its developments. This includes check analyses on a given sample, to examine limitations of the procedure, determine its precision and repeatability, and define precautions in sampling, pretreatment or analysis which must be observed to get satisfactory results.

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[*] Air Pollution Measurement Technique Development - Fiscal Years 1972-1977, First Draft July 1971, CPA 22-69-154.

P = promulgate the official method; one method is selected from the alternates available, and promulgated for the guidance of all agencies or others using the new monitor or method. This becomes the reference standard against which all measurements by this technique or its unofficial alternates are to be compared. It is a self-contained set of instructions specifying limits, precautions, standard sample sources, methods of calibration, criteria for the evaluation of satisfactory performance for a given instrumental or group of instruments, and limits of comparability with data obtained by alternate methods in common use. This promulgated technique must be legally defensible. Promulgation of remote techniques may be prevented because of the undesirable aspect of the invasion of privacy.

MEDIA OR CATEGORY	FUNCTION	USE	POLLUTANT OR PROPERTY	STAGE OF DEVELOPMENT	SENSOR OR METHOD	
AIR	AMBIENT	IN-SITU	SO_2 & SULFUR COMPOUNDS	C	SELECT ONE COMMERCIAL WET SO_2 SAMPLER	2-1
				D	NON WET, CHEMICAL, CUMULATIVE 24 HR SENSOR	2-2
			TOTAL GASEOUS SULFUR COMPOUNDS	P	FLAME PHOTOMETRIC DETECTOR	2-3, COUPLED WITH OR SO_2 IN ADMIXTUR
			H_2S	D	1 HR. CUMULATIVE & HIGHER, SENSOR	2-4
		REMOTE	SO_2	T&E	REMOTE SO_2 MONITOR	2-5, BARRINGER ,UV SPECTROMETRICS
		IN-SITU	MOLECULAR H_2SO_4 MISTS	D	OFFICIAL METHOD FOR SULFURIC ACID PLANT EMISSION STANDARD	2-6, SEPARATE NEED
			PARTICULATE	P	TAPE SAMPLING INTERIM METHOD	2-7a,
				T&E	REVISE OFFICIAL METHOD FOR HOURLY TOTAL PARTICULATE MASS LOADING	2-7b,
				D	IMPROVED DEVICE(S) FOR CUMULATIVE TOTAL MASS	2-8
				T&E	COMMERCIAL SIZE DISTRIBUTION SAMPLER FOR SUSPENDED PARTICULATES	2-9
				D	NEW INSTRUMENT FOR RESPIRABLE PARTICULATES, 0.1 TO 1.0 MICRON	2-10
				T&E	VISIBILITY DETECTION FOR AMBIENT AIR	2-11a, NEPHELOMETR
				P	VISIBILITY DETECTION METHOD	2-11b, CONTINUE
			PARTICULATE, SULFATE AND NITRATE	R	METHOD FOR CHEMICAL CHANGE IN PARTICULATES BETWEEN TIME OF COLLECTION AND ANALYSIS	2-12,
			CO	C	METHOD FOR CO AMBIENT MEASUREMENT	2-13, NDIR, GAS CANDIDATES
			CO	T&E	CONTINUE METHODS EVALUATION	2-14, AKRON AND/OR TECHNIQUES
			CO	D	AMBIENT CO DOSIMETER	2-15, FOR PERSONAL MONITOR
			CO_2	C	NDIR INSTRUMENT & METHOD	2-16a, 2-16b
			NO_2	C	JACOBS-HOCKHEISER MODIFIED SALTZMAN MANUAL METHOD	2-17, COLORIMETRIC,
			NO_2	T&E	SELECT AMBIENT NO_2 INSTRUMENT	2-18, GALVANOMETRIC,
			NO_2	D	CUMULATIVE NO_2 MONITOR	2-19, SOLID ABSORB
			NO	T&E	DIRECT MEASURE OF NO METHOD	2-20, OZONE TITRAT
			NO	D	CUMULATIVE NO INSTRUMENT	2-21
		REMOTE	NO & NO_2	D	WIDE AREA MONITOR FOR NO AND NO_2	2-22, BARRINGER CO
		IN-SITU	HNO_3 MISTS	T&E	TENTATIVE STANDARD METHOD FOR AMBIENT MOLECULAR HNO_3	2-23,
			TOX	P	TOTAL OXIDANT OFFICIAL METHOD	2-24, KI METHOD AL

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REMARKS
2-1
2-2
2-3, COUPLED WITH GAS CHROMATOGRAPH TO ANALYZE H_2S, RSH, RSR, OR SO_2 IN ADMIXTURES
2-4
2-5, BARRINGER UV CORRELATION SPECTROMETER OR THE SPECTROMETRICS DERIVATIVE SPECTROMETER
2-6, SEPARATE NEED FOR GASEOUS H_2SO_4 AND SULFATES IN PARTICULATES
2-7a,
2-7b,
2-8
2-9
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2-11a, NEPHELOMETRY AND/OR OPTICAL TRANSMISSION
2-11b, CONTINUE R&D FOR IMPROVEMENTS
2-12,
2-13, NDIR, GAS CHROMATOGRAPHY & FLAME IONIZATION ARE CANDIDATES
2-14, AKRON AND/OR MERCURIC OXIDE/ATOMIC ABSORPTION TECHNIQUES
2-15, FOR PERSONAL USE OR SLAVE STATION AROUND A CONTINUOUS MONITOR
2-16a, 2-16b
2-17, COLORIMETRIC, TENTATIVE STANDARD MANUAL METHOD USE
2-18, GALVANOMETRIC, ELECTROCHEMICAL OR FLAME PHOTOMETRIC APPROACH
2-19, SOLID ABSORBENTS OR PLUG-IN ELECTROCHEMICAL CELLS
2-20, OZONE TITRATION , FLAME PHOTOMETRY, ETC.
2-21
2-22, BARRINGER CORRELATION SPECTROMETER
2-23,
2-24, KI METHOD ALREADY IS A TENTATIVE STANDARD METHOD

R - RESEARCH STAGE
D - DEVELOPMENT STAGE
T&E - TEST & EVALUATION
C - COLLABORATIVE
P - PROMULGATION

TABLE B-7-1

PROPOSED AIR
POLLUTION MONITORING
TECHNIQUES

B

MEDIA OR CATEGORY	FUNCTION	USE	POLLUTANT OR PROPERTY	STAGE OF DEVELOPMENT	SENSOR OR METHOD	
AIR	AMBIENT	IN-SITU	O_3	C	OZONE INSTRUMENT	2-25, OZONE CH
			O_3	D	SIMPLE CUMULATIVE OZONE SENSOR	2-26, EXPOSURE
			THC ABOVE METHANE	P	METHOD FOR TOTAL HYDROCARBONS ABOVE METHANE	2-27, DIFFERENTIAL PRECOMBUSTION USI
			HC	T & E	MODIFIED FLAME IONIZATION DETECTION (FID) FOR SPECIFIED HYDROCARBONS METHODS	2-28, STATE OF GENERATED H & O_2,
			HC	R	REACTIVE HYDROCARBON METHOD	2-29, GAS CHROMATO SIMPLEST DETECTOR
			ALDEHYDES	D	METHOD FOR AMBIENT ALDEHYDES	2-30, IR SPECTROSC
			HF	T & E	METHOD FOR HYDRO-FLUORIDES	2-31, NEUTRAL BUFF MICRODIFFUSION ME
			FLUORIDE PARTICULATES	D	METHODS FOR WATER SOLUBLE & INSOLUBLE FLUORIDE PARTICULATES	2-32
			Pb	C	OFFICIAL METHOD FOR ORGANIC AND VOLATILE INORGANIC LEAD	2-33, ATOMIC ABSO ARE CANDIDATES
			CARCINOGENS	D	MANUAL METHOD FOR POLYCYCLIC AROMATIC MATERIALS FOR CARCINOGENS,(POM)	2-34, UV ABSORBANC CHROMATOGRAPHY FO
			BaP	T & E	AUTOMATED BaP INSTRUMENT	2-35a, COLUMN SOR
			BaP	D	BENZ-A-PYRENE PRELIMINARY METHOD	2-35b
			POM	R	INTERIM METHOD FOR POLYCYCLIC AROMATIC MATERIALS (POM)	2-36, SPECTROSCOPY EFFECTS OR SPECIF
			ASBESTOS	P	INTERIM METHOD BY MANUAL COUNTING	2-37a
			ASBESTOS	R	CONTINUE RESEARCH FOR INSTRUMENT	2-37b, IR SPECTRO
			MERCURY	C	INTERIM METHOD FOR MERCURY FOR TENTATIVE STANDARD	2-38, ATOMIC ABSO COLORIMETRY ARE C
			TRACE METALS	D	INTERIM TRACE METAL METHODS FOR CADMIUM, BERYLLIUM & OTHER TRACE METALS	2-39, X-RAY FLUOR ELECTRON EMISSION ARE CANDIDATES
			Cl & HCl	D	CHLORINE/HCl DETECTOR	2-40, WET CHEMIST
			NON-METALS	D	METHOD FOR ARSENIC & SELENIUM	2-41, X-RAY FLUOR
			ODORS	P	METHOD FOR ODOR PANELS	2-42, BASED ON T
			SPECIFIC ODORANTS	R	INSTRUMENTED MEASUREMENT OF ODORANT COMPOUNDS & COMPOUND TYPES	2-43, ORGANOLEPTIC PULP & PAPER MILL
			ODORS	R	CORRELATION OF ORGANOLEPTIC MEASUREMENTS & GENERAL PUBLIC RESPONSE	2-44, RESEARCH BE MEASURED LEVELS W
	SOURCE - STATIONARY		SO_x	C	MANUAL ANALYTICAL METHODS FOR PARTICULATE SULFATES, HCl MIST, SO_3 & SO_2	3-23,
			SO_2	T & E	CONTINUOUS SO_2 INSTRUMENTS TESTED & EVALUATED FOR COMBUSTION & NON COMBUSTION SOURCES	3-45, NDIR, UV A DILUTION AND AMBI
			H_2SO_4 MIST	D	CONTINUOUS MONITOR FOR SULPHURIC ACID MISTS	3-46
			SO_x	C	MANUAL METHOD FOR TOTAL SO_x USING PHENOL DI-SULFONIC ACID	3-24, COLORIMETR
			HNO_3 & NO_3^-	D	MANUAL METHODS NITRIC ACID MIST & PARTICULATE NITRATES	3-24

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	REMARKS
	2-25, OZONE CHEMILUMINESCENCE TECHNIQUE
	2-26, EXPOSURE PLATE OR INDICATOR TUBE APPROACH
	2-27, DIFFERENTIAL MEASUREMENTS USING SELECTIVE ADSORPTION OR PRECOMBUSTION USING HOT PLATINUM COIL & FLAME IONIZATION DETECTION
	2-28, STATE OF PENNSYLVANIA METHOD OR FID WITH ELECTROLYTIC GENERATED H & O_2, FOR REVISED OFFICIAL METHOD
	2-29, GAS CHROMATOGRAPHY OR SUBTRACTION ABSORPTION, AND SIMPLEST DETECTOR SYSTEM PREFERRED
	2-30, IR SPECTROSCOPY, DERIVATIVE UV OR POLAROGRAPHY
	2-31, NEUTRAL BUFFERED SPECIFIC ION ELECTRODE, COLORIMETRY OR MICRODIFFUSION METHOD
RIDE PARTICULATES	2-32
ORGANIC LEAD	2-33, ATOMIC ABSORPTION OR COLORIMETRIC ANALYSIS ARE CANDIDATES
	2-34, UV ABSORBANCE, SPECTROFLUORIMETRY OR THIN LAYOR CHROMATOGRAPHY FOR INTERIM STANDARD NEEDED
	2-35a, COLUMN SORBTION PLUS GAS CHROMATOGRAPHY
	2-35b
ERIALS (POM)	2-36, SPECTROSCOPY BY UV, MS, IR, NMR, ESR, FLUORESCENCE, THERMAL EFFECTS OR SPECIFIC COLOR REACTIONS ARE CANDIDATES
	2-37a
	2-37b, IR SPECTROSCOPY, ELECTRON REFLECTION SCANNING, ETC.
ANDARD	2-38, ATOMIC ABSORPTION, NEUTRON ACTIVIATION, COLORIMETRY ARE CANDIDATES
RYLLIUM	2-39, X-RAY FLUORESCENCE, ATOMIC ABSORPTION (FLAME PHOTOMETRY) ELECTRON EMISSION IN UV & VISIBLE, MICROWAVE EMISSION, ETC. ARE CANDIDATES
	2-40, WET CHEMISTRY AVAILABLE AS BACKUP METHOD
	2-41, X-RAY FLUORESCENCE OR WET CHEMISTRY ANALYSIS
	2-42, BASED ON THRESHOLDS OF ODOR DISCRIMINATION
DS	2-43, ORGANOLEPTIC METHODS FOR PETROLEUM REFINERIES, FOUNDRIES, PULP & PAPER MILLS, ETC.
	2-44, RESEARCH BETWEEN ODOR RESPONSES, ODOR PERSISTENCIES, & MEASURED LEVELS WITH EFFECTS OF AUXILIARY BODIES
	3-23,
ED	3-45, NDIR, UV ABSORPTION, UV CORRELATION SPECTROMETORS, OR DILUTION AND AMBIENT SO_2 METHODS USED
	3-46
	3-24, COLORIMETRIC TECHNIQUE
	3-24

R - RESEARCH
D - DEVELOPMENT
T&E - TEST & EVALUATION
C - COLLABORATIVE
P - PROMULGATION

TABLE B-7-2

PROPOSED AIR
POLLUTION MONITORING
TECHNIQUES
(CONTINUED)

B

MEDIA OR CATEGORY	FUNCTION	USE	POLLUTANT OR PROPERTY	STAGE OF DEVELOPMENT	SENSOR OR METHOD	REMAR
AIR	SOURCE STATIONARY	IN-SITU	NO, NO_2, & NO_x	T&E	CONTINUOUS NO_x MONITORING FOR COMBUSTION & NON-COMBUSTION SOURCES	3 - 47,
			VARIOUS	D	AUTOMATIC ISOKINETIC SAMPLING DEVICE & GAS VELOCITIES IN STACKS	3 - 61
			TOTAL PARTICULATES	P	MANUAL METHOD FOR TOTAL PARTICULATE MASS	3 - 22,
			TOTAL PARTICULATES	D	MANUAL METHOD FOR CONSTANT VOLUME SAMPLING FOR TOTAL PARTICULATE MASS	3 - 65,
			TOTAL PARTICULATES	D	INSTRUMENT FOR TOTAL PARTICULATE MASS LOADING	3 - 39, SAMPLE ABSORP
			VISIBILITY	P	MANUAL METHOD FOR PLUME OPACITY USING SMOKESHADE TECHNIQUE	3 - 25,
				T&E	IN-STACK TRANSMISSOMETER	3 - 40,
			PARTICULATE	D	MANUAL METHOD FOR DETERMINATION OF PARTICLE SIZE DISTRIBUTION	3 - 38,
			PARTICULATE	D	AUTOMATIC PARTICLE SIZE DISTRIBUTION SAMPLER	3 - 41,
			PARTICLE COMPOSITION	D	ON-STREAM ANALYZER FOR MEASUREMENT OF COMPOSITION OF PARTICULATES	3 - 44,
			ASBESTOS	T&E	METHOD FOR ASBESTOS SOURCE TESTING	3 - 32
			MERCURY	T&E	METHOD FOR GASEOUS MERCURY	3 - 33
			Pb	D	MANUAL METHOD FOR LEAD	3 - 28,
			BERYLLIUM	D	MANUAL METHOD & SAMPLER BERYLLIUM SOURCES	3 - 34,
			NON-METALS	T&E	METHOD FOR ARSENIC & SELENIUM	3 - 35
			MERCURY	T&E	CONTINUOUS MERCURY MONITOR	3 - 42,
			CO	T&E	BATCH & CONTINUOUS CO METHOD SELECTED	3 - 26,
			TOTAL HC	C	BATCH TOTAL HYDROCARON DETECTORS	3 - 29,
			SPECIFIC HC	D	DETECTORS FOR CARBON-HYDROGEN BONDS & FOR OXYGEN, NITROGEN OR HALOGENS	3 - 48, COLUMN &
			TOTAL ODOR	T&E	DYNAMIC OLEFACTORY METHOD FOR TOTAL ODORS	3 - 37
			SULFUR ODORANTS	T&E	INSTRUMENT FOR H_2S & TOTAL REDUCED SULFUR ODORANTS	3 - 51,
			AMMONIA & AMINES	D	SEPARATION COLUMNS FOR AMMONIA & AMINES	3 - 52
			ORGANIC ACIDS & ALDEHYDES	D	SEPARATION COLUMNS FOR ORGANIC ACIDS & ALDEHYDE ODORANTS	3 - 53,
			SPECIFIC ODORANTS	R	SPECIFIC ODORANTS METHODS FROM VARIOUS INDUSTRIAL PROCESSES	3 - 64; INCINER
			FLUORIDES	T&F	MANUAL METHODS FOR FLUORIDE EMISSIONS FROM VARIOUS INDUSTRIAL PROCESSES	3 - 30; WORKS
			CHLORIDES	T&E	MANUAL METHOD FOR CHLORIDE EMISSIONS FROM VARIOUS INDUSTRIAL PROCESSES	3 - 31; INCINER
			FLUORIDES	T&E	INSTRUMENTS FOR CONTINUOUS & INTERMITTENT FLUORIDE EMISSIONS	3 - 49, TECHNIQ

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A

	REMARKS
-COMBUSTION	3 - 47, MONSANTO
ELOCITIES	3 - 61,
	3 - 22,
R TOTAL	3 - 65,
	3 - 39, PIEZO CRYSTAL-VIBRATION APPROACH, PAPER TAPE SAMPLERS-TRANSMISSION/REFLECTION TECHNIQUES OR BETA ABSORPTION
ADE TECHNIQUE	3 - 25, RINGELMANN APPROACH, BASED ON WHITE SMOKE GUIDE
	3 - 40, RELATE TO RINGELMANN APPROACH
SIZE	3 - 38, 0.05 TO 0.5 MICRONS
	3 - 41, ERC DEVICE
ITION	3 - 44, NRL X-RAY FLUORESCENCE APPROACH
	3 - 32
	3 - 33
	3 - 28, FOR LEAD SMELTERS
	3 - 34, 3 - 43
	3 - 35
	3 - 42, UV SPECTROSCOPY (OLIN, BARRINGER, DUPONT)
	3 - 26, NDIR (BECKMAN, BENDIX, MSA, LIRA)
	3 - 29, FLAME IONIZATION DETECTOR OR NDIR
GEN,	3 - 48, GAS CHROMATOGRAPHIC SYSTEM USING SEPARATION COLUMN & DETECTORS FOR SPECIFIC COMPOUNDS
	3 - 37
ANTS	3 - 51, SEPARATION COLUMN FOLLOWED BY FLAME IONIZATION DETECTOR
	3 - 52
DE ODORANTS	3 - 53, GAS CHROMATOGRAPH COLUMNS & DETECTORS
IAL PROCESSES	3 - 66; PULP & PAPER, PETROLEUM REFINERIES, SEWAGE SLUDGE INCINERATORS, ANIMAL RENDERING
RIOUS	3 - 30; PHOSPHATE FERTILIZER, LIME PLANTS, IRON & STEEL WORKS
OUS	3 - 31; HCl PLANTS, CHLORINE & CAUSTIC PLANTS, & MUNICIPAL INCINERATORS
RIDE EMISSIONS	3 - 49, COLORIMETRIC (LEIGH) OR SPECIFIC ION ELECTRODE TECHNIQUE (CORNING, ORION)

R - RESEARCH
D - DEVELOPMENT
T & E - TEST & EVALUATION
C - COLLABORATIVE
P - PROMULGATION

TABLE 8-7-1

PROPOSED AIR
POLLUTION MONITORING
TECHNIQUES
(CONTINUED)

B

MEDIA OR CATEGORY	FUNCTION	USE	POLLUTANT OR PROPERTY	STAGE OF DEVELOPMENT	SENSOR OR METHOD	
AIR	SOURCE-STATIONARY	IN-SITU	CHLORIDES	T & E	INSTRUMENT FOR CONTINUOUS AND INTERMITTENT CHLORIDE EMISSIONS	3-50, UV ABSO TECHNIQUE (CO
		REMOTE	NO & SO_2	R	REMOTE MONITOR FOR SINGLE SOURCE GASEOUS EMISSIONS	3-55,
		REMOTE	NO_X, SO_2 & HC	D	REMOTE MONITOR FOR AREA SOURCE GASEOUS EMISSIONS	3-56,
		REMOTE	OPACITY	D	REMOTE MONITOR FOR PLUME OPACITY	3-57
		REMOTE	PARTICULATE	D	REMOTE MONITOR FOR SINGLE SOURCE EMISSIONS - PARTICULATE MASS LOADING	3-58
		REMOTE	STACK VELOCITY	D	REMOTE MONITOR FOR STACK EFFLUENT VELOCITY	3-59
		IN-SITU	TSP, VISIBILITY, SO_2, NO_X	C	SOURCE TEST METHOD - FOSSIL FUEL STEAM-ELECTRIC GENERATING PLANTS	3-1
			TSP, VISIBILITY, NO_X	C	SOURCE TEST METHOD - MUNICIPAL INCINERATORS	3-2
			TSP, SO_2, NO_X	C	SOURCE TEST METHOD - CEMENT PLANTS	3-3
			TSP, SO_2, SO_3, H_2SO_4	C	SOURCE TEST METHOD - SULPHURIC ACID PLANTS	3-4
			TSP, NO_X, HNO_3	C	SOURCE TEST METHOD - NITRIC ACID PLANTS	3-5
			ASBESTOS	C	SOURCE TEST METHOD - ASBESTOS PRODUCTION, FABRICATION AND DEMOLITION PROJECTS	3-6
			Be AND COMPOUNDS	C	SOURCE TEST METHOD - BERYLLIUM PLANTS	3-7
			VARIOUS	C	SOURCE TEST METHOD - PETROLEUM REFINERIES	3-8, TSP, VIS ODOR, CO, HC,
			TSP, NO_X & SO_2	T & E	SOURCE TEST METHOD - ASPHALT BATCHING PLANTS	3-9
			TSP, SO_2	C	SOURCE TEST METHOD - IRON AND STEEL PLANTS	3-10
			ODORS	C	SOURCE TEST METHOD - ANIMAL RENDERING PLANTS	3-11
			TSP, ODORS, SO_2, Hg	T & E	SOURCE TEST METHOD - PULP & PAPER PLANTS	3-12
			FLUORIDES, TSP	T & E	SOURCE TEST METHOD - ALUMINUM REDUCING PLANTS	3-13
			FLUORIDES, TSP	C	SOURCE TEST METHOD - PHOSPHATE FERTILIZER AND PHOSPHOROUS REDUCING PLANTS	3-14
			TSP, SO_2, CO	T & E	SOURCE TEST METHOD - GREY IRON FOUNDRIES, BRASS & BRONZE REFINING, & FERRO-ALLOY PLANTS	3-15
			TSP, FLUORIDES	T & E	SOURCE TEST METHOD - LIME PLANTS	3-16
			TSP	T & E	SOURCE TEST METHOD - COTTON GINS, AUTO ASSEMBLY, SOAP MANUFACTURING, COAL CLEANING PLANTS, GRAIN MILLING & HANDLING PLANTS	3-17
			SPECIFIC ORGANICS	T & E	SOURCE TEST METHOD - GRAPHIC ARTS PLANTS, PAINT & VARNISH PLANTS	3-18
			Cl_2 & HCl	T & E	SOURCE TEST METHOD - CHLORINE, CAUSTIC PLANTS & HCl PLANTS	3-19
			VARIOUS	T & E	SOURCE TEST METHOD - PETROCHEMICAL & OTHER CHEMICAL PLANTS	3-20, TSP, T
			SO_2, NO_X, TSP	T & E	SOURCE TEST METHOD - INDUSTRIAL BOILERS	3-21

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	REMARKS
TENT	3-50, UV ABSORPTION (DUPONT) OR SPECIFIC ION ELECTRODE TECHNIQUE (CORNING, ORION)
	3-55,
	3-56,
	3-57
IONS -	3-58
	3-59
	3-1
RATORS	3-2
	3-3
PLANTS	3-4
TS	3-5
TION,	3-6
S	3-7
RIES	3-8, TSP, VISIBILITY, NO_X, SULPHUR COMPOUNDS, ODOR, CO, HC, SO_2
S PLANTS	3-9
PLANTS	3-10
G PLANTS	3-11
ANTS	3-12
NG PLANTS	3-13
LIZER AND	3-14
RIES, BRASS & BRONZE	3-15
	3-16
TO ASSEMBLY, ANTS, GRAIN MILLING	3-17
ANTS,	3-18
TIC PLANTS &	3-19
& OTHER CHEMICAL PLANTS	3-20, TSP, THC, INORGANIC GASES
ERS	3-21

R - RESEARCH STAGE
D - DEVELOPMENT STAGE
T & E - TEST & EVALUATION
C - COLLABORATIVE
P - PROMULGATION

TABLE [illegible]

PROPOSED AIR
POLLUTION MONITORING
TECHNIQUES
(CONTINUED)

B

MEDIA OR CATEGORY	FUNCTION	USE	POLLUTANT OR PROPERTY	STAGE OF DEVELOPMENT	SENSOR OR METHOD	
AIR	SOURCE-STATIONARY	IN-SITU	TSP, ODORS	T&E	SOURCE TEST METHOD – SEWAGE SLUDGE INCINERATORS	3-70
		IN-SITU	TSP,SO_2,Pb	T&E	SOURCE TEST METHOD – NON FERROUS SMELTERS & SECONDARY LEAD SMELTERS	3-71
		VARIOUS	VARIOUS	R	COMPARISON OF DIFFERENT EMISSION METHODS	3-60, REMOT
		IN-SITU	VARIOUS	D	MANUAL METHOD FOR TEMP. PROFILE IN STACKS	3-62
		IN-SITU	CADMIUM	D	MANUAL METHOD FOR CADMIUM	3-67
		IN-SITU	FLUORIDE	T&E	METHOD FOR ANIMAL FEED DEFLUORINATION	3-69
	METEOROLOGY	REMOTE	TEMPERATURE	D	MONITOR FOR DETERMINATION OF VERTICAL TEMPERATURE PROFILES	5-1, SPERRY
		REMOTE	WIND SPEED AND TURBULENCE	D	MONITOR USING LASER CROSS-BEAM TECHNIQUE FOR REMOTE WINDS AND TURBULENCE	5-2
		REMOTE	WIND SPEED AND TURBULENCE	D	ACOUSTIC DOPPLER MONITOR FOR WIND SPEED & TURBULENCE	5-3
		REMOTE	MOISTURE	D	OPTICAL TECHNIQUE FROM ATMOSPHERIC MOISTURE PROFILES	5-4, NOAA DE
	HEALTH & ECONOMIC EFFECTS	IN-SITU	SO_2,NO_x,TOX	D	PERSONAL DOSIMETER FOR SO_2, NO_X, TOX	6-1
	HEALTH & ECONOMIC EFFECTS	IN-SITU	AEROALLERGENS	R	METHOD FOR SPECIFIC AEROALLERGENS	6-2
	HEALTH & ECONOMIC EFFECTS	IN-SITU	VARIOUS	D	INSTR. AND METHODS TO SUPPORT EFFECTS RESEARCH	6-3a; 6-3b
	SOURCE-MOVING	IN-SITU	VARIOUS	D	SAMPLER FOR RAW AUTO EMISSIONS-SIMPLER PROPORTIONATING DEVICE	4-1; NO_X , T
				D	SIMPLIFIED EXHAUST FLOW AND/OR CARBURETOR AIR INTAKE SENSOR	4-2; NO_X, TSP
				D	SIMPLIFIED CONSTANT MASS SAMPLER FOR ON-THE-ROAD TESTING	4-3
			PARTICULATES	D	METHOD FOR PARTICULATE SAMPLING CONSISTENT WITH CONSTANT MASS SAMPLER	4-4
			VARIOUS	D	METHOD FOR AUTO GAS TURBINE EMISSIONS	4-5
			VARIOUS	D	METHOD FOR RANKINE CYCLE & OTHER ADVANCED POWERPLANT EMISSIONS	4-6
			ASBESTOS	D	METHOD FOR AUTO ASBESTOS EMISSIONS	4-7
			PARTICULATES	D	METHOD FOR RUBBER PARTICLE EMISSION FROM MOTOR VEHICLES IN OPERATION	4-8
			VARIOUS	T&E	SIMPLIFIED METHOD FOR END OF ASSEMBLY LINE EMISSIONS TESTING	4-9
				D	METHOD FOR EMISSIONS TEST FOR STATE INSPECTION FOR SELECTED DRIVING CYCLE	4-10
				D	METHOD FOR EMISSION TEST FOR STATE SPOT CHECKS AT IDLING CONDITIONS	4-11
				D	SIMPLE SAMPLING METHOD FOR AUTO REPAIRERS TO RESTORE VEHICLE TO PROPER EMISSION STANDARD	4-12
			THC LESS METHANE	D	CONTINUOUS TOTAL HYDROCARBON LESS METHANE SENSOR	4-13
			HEAVY HYDROCARBON	D	METHOD FOR MEASURING HEAVY HYDROCARBON EMISSIONS	4-14

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	REMARKS
TORS	3-70
& SECONDARY LEAD SMELTERS	3-71
	3-60, REMOTE, SPATIALLY AVERAGED IN-STACK, OUT OF STACK, MANUAL
	3-62
	3-67
	3-69
RATURE PROFILES	5-1, SPERRY RAND THERMASONDE
R REMOTE WINDS AND TURBULENCE	5-2
RBULENCE	5-3
PROFILES	5-4, NOAA DEVELOPMENT
	6-1
	6-2
CH	6-3a; 6-3b
RTIONATING DEVICE	4-1; NO_x , TSP, CO, HC
R INTAKE SENSOR	4-2; NO_x, TSP, CO, HC
-ROAD TESTING	4-3
WITH CONSTANT MASS	4-4
	4-5
WERPLANT EMISSIONS	4-6
	4-7
OR VEHICLES IN OPERATION	4-8
EMISSIONS TESTING	4-9
ION FOR SELECTED DRIVING	4-10
CKS AT IDLING CONDITIONS	4-11
RESTORE VEHICLE TO	4-12
NSOR	4-13
SIONS	4-14

R - RESEARCH
D - DEVELOPMENT
T & E - TEST & EVALUATION
C - COLLABORATIVE
P - PROMULGATION

TABLE 6-[illegible]

PROPOSED AIR
POLLUTION MONITORING
TECHNIQUES
(CONTINUED)

B

MEDIA OR CATEGORY	FUNCTION	USE	POLLUTANT OR PROPERTY	STAGE OF DEVELOPMENT	SENSOR OR METHOD	
AIR	SOURCE-MOVING	IN-SITU	CO	T&E	FLUORESCENT CO SENSOR FOR 1975 STANDARDS.	4-16,
			NO_X	T&E	MONITOR FOR NO_X FOR USE WITH 1973 STANDARD.	4-17,
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R - RESEARCH
D - DEVELOPMENT
T & E - TEST & EVALUATION
C - COLLABORATIVE
P - PROMULGATION

TABLE II-7-6

PROPOSED AIR
POLLUTION MONITORING
TECHNIQUES
(CONCLUDED)

B

ATTACHMENT B.7.2

Additional Information on In-Situ Monitoring Techniques for Air Pollutants

Chemiluminescence relies on the fluorescence caused by the chemical reaction of a pollutant gas on a surface treated with a suitable dye (rhodamine B in the case of ozone monitors). The light emitted from the surface is collected in a photomultiplier tube, the resulting current being proportional to the concentration of the pollutant gas.

Colorimetry relies on a color change in a liquid reagent, caused by the absorption of an atmospheric contaminant. In some cases, this color change is noted by eye; but in most monitors the fluid is passed through a flow colorimeter that measures absorption at a fixed wavelength. The resultant color change is proportional in intensity to the concentration of the contaminant.

Conductimetry involves the absorption of an atmospheric contaminant in a liquid reagent (the contaminant must be an electrolyte in solution) and subsequent measurement of the electrolyte conductivity, which is then related to the concentration of contaminant in the sample gas. In sulfur dioxide monitors, the gas is absorbed in a deionized water-based reagent. This absorption produces an acid whose conductance can be measured with a conductivity cell. The change in conductivity is proportional to the sulfur dioxide absorbed.

Coulometry involves a reaction between the atmospheric pollutant being measured and a substance within an electrolytic cell. This reaction produces a change in the electromotive force, which is related to the pollutant concentration.

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Flame ionization is used to measure the concentration of organic compounds in the atmosphere. The air sample is burned in a hydrogen-oxygen flame, causing the carbon atoms in the organic material to become ionized. The ions are collected, and the measured charge is then proportional to the organic-pollutant concentration in the air stream.

Flame photometry determines pollutant concentrations by measuring the intensity of the visible and ultraviolet spectra emitted by pollutant molecules when the sample gas stream is burned.

Gas chromatography relies on the difference in mobility of different molecular species traversing a column of packing material. If a gas sample is introduced at one end of the column, the molecular species move through the column at different rates and appear at the end of the column sequentially, where they can be identified by a variety of techniques, including flame photometry.

Infrared spectroscopy determines the concentration of gaseous pollutants by measuring the absorption of electromagnetic energy by the characteristic vibrational excitations of the pollutant molecules. This approach can be used by both remote and in-situ monitoring techniques.

Microwave spectroscopy can determine the concentration of any gaseous pollutant with a dipole moment by measuring the absorption of electromagnetic radiation by the characteristic rotational excitations of the pollutant molecules. This approach can be used by both remote and in-situ monitoring techniques.

Nondispersive infrared (NDIR) involves the absorption of infrared radiation by an atmospheric contaminant. An infrared source, usually Nichrom filaments, generates two parallel beams of infrared radiation. One beam traverses a sample cell, and the other traverses a comparison cell containing a nonabsorbing gas. The emergent radiation from both beams is directed to a detector cell, which consists of two gas-filled compartments separated by a flexible diaphragm. An interrupter, or "chopper," located between the radiation source and the cells alternately blocks radiation to the sample cell and to the comparison cell. When the infrared beams are equal, then equal amounts of radiation are entering the detector cell and a "zero" or background reading is recorded. When the gas to be analyzed is introduced into the sample cell, it absorbs (and reduces) the radiation reaching the detector via the sample beam. The beams, therefore, become of unequal strength, thus causing the detector gases to expand or contract and the diaphragm to move in response. This movement, when amplified, gives an indication of the concentration of the sample gas. The NDIR approach can be used by both remote and in-situ monitoring techniques.

Most of these methods, especially the wet-chemical ones, have numerous drawbacks. One overall deficiency of prime concern is the excessive failure rate of almost all air sampling instruments. While much attention has been given to their accuracy, specificity, and similar characteristics little progress has been made in improving the reliability of sensor operation and for the integration of the monitoring techniques into a regional system.

ATTACHMENT B.7.3

Additional Information on Remote Monitoring Techniques for Air Pollution

Several remote monitoring techniques which have possibilities are described below. None of the techniques have been used operationally and may never be perfected sufficiently for operational (promulgated) use. Should any remote techniques be promulgatable the question of the invasion of privacy may prevent the final stage (promulgation) for legal purposes.

B.7.3.1 Active Remote Techniques - Laser Based

At the present time the Environmental Protection Agency is monitoring over 10 atmospheric pollutants throughout the United States. In general, over 90 percent of these pollutants are in a gaseous state in concentrations that vary between 0.01-10 ppm for molecules and 0.01-10 ppb for metal vapors. Progress in monitoring air quality has been impeded in the past by a lack of techniques for detecting pollutants in three dimensions over large expanses of the atmosphere with sufficient resolution in time and space to permit qualitative and quantitative sensing in real time. However, the advent of the pulsed laser coupled with radar techniques (lidar) marked the beginning of major progress in quantitative remote monitoring of the atmosphere. More recently, other techniques previously enumerated have also taken on a major importance in the field of air quality surveillance. As a result, a wide range of applications have been explored with increasingly sophisticated techniques. In many of these applications, lasers are used as atmospheric illuminators in preference to other light sources because the monochromaticity of the laser allows discrimination against background noise through the use of narrow band filters. In addition, the high peak power and narrow pulses yield good signal-to-noise ratios and range resolution, even for low cross-section scatterers. Practical laser systems now range in peak pulse power to several hundred megawatts. Pulse widths are as short as 10^{-8} seconds and pulse repetition rates are as high as 1000 pps. However, not all the desired characteristics of frequency, power, pulse width, pulse repetition rate, coherence, beam divergence, efficiency, and compact size are available in the same laser.

Since all molecular air pollutants have characteristic absorption spectra throughout the electromagnetic spectrum,it should be possible to detect these pollutants through absorption spectroscopy techniques. However, these techniques have not been practical in the past because the small absorptions (caused by the low concentration of most pollutants) have made it necessary to use very long path length absorption cells. In addition, data collection was very slow due to the limited source strength available from conventional light sources. The recent introduction of a number of different types of IR lasers has made remote monitoring of air pollutants a practical reality and demonstrated that these techniques have adequate sensitivity to detect pollutants at the concentrations found in city air.

In order to utilize these intense sources to measure the very weak IR absorptions produced by air pollutants, it is necessary to detect the resonance absorption of the gas rather than the attenuation of the beam as it passes through the sample since the attenuation will be very small for reasonable path lengths and will be hard to detect. Other techniques employed for detecting air pollutants include Mie and Rayleigh scattering, Raman back scattering, and angular scattering phenomena involving polarization effects.

Because of specific molecular interaction, absorption and backscattering, electro-optic techniques employing lasers have the unique capability of identification of atmospheric gases. In addition to studying the properties of the gaseous components of the atmosphere, the distribution, intensity, and dynamics of precipitation, clouds, and aerosol particles are also potentially available for study.

B.7.3.2 Passive Remote Techniques

The techniques cited above using lasers as atmospheric illuminators are examples of active remote monitoring techniques. In contrast to this approach other investigators are concentrating on passive methods which require highly sophisticated correlation techniques for detecting atmospheric pollutants. Until recently the passive approach centered on dispersive elements such as gratings and prisms for separating the information content of incoming signals. This method had the disadvantage of requiring long integration times since incoming signals were usually faint. More recently, techniques have been developed, based on interferometric principles, that carry out correlation in real-time. These devices correlate against the fourier transform of the spectrum rather than the spectrum itself. The correlation interferometer may prove to be particularly suitable for application in the infrared due to its large light throughout this region and the fact that almost all gases have complex and characteristic spectral signatures in this region.

Instruments of the correlation interferometer type have also been constructed for use in the UV and visible portions of the spectrum and correlation masks have been prepared for many common air pollutants such as SO_2, NO_2, NO and some of the halogens.

B.7.3.3 Derivative Spectrometry

Still another powerful analytical technique for detection of air pollutants is the derivative spectrometer. This instrument offers an alternate approach to the detection and measurement of substances by measuring the gradient (derivative) of absorbivity or reflectivity with wavelength. This approach has proven very effective for the detection of weak spectral features because the derivative of the proven spectrum exhibits much more structure than is immediately apparent in the absorption or reflectance spectrum itself.

Derivative spectra may be obtained by derivative densitometry of spectrograms or by computer processing of recorded spectra. An alternative approach is the electromechanical or electronic differentiation of the output of a scanning monochromator. A fourth technique is wavelength modulation during spectral scanning employing simultaneous wavelength modulation at high frequency over narrow spectral regions with wavelength scanning at a lower rate.

The sensitivity of the derivative spectrometric technique to faint absorption features makes it valuable for the detection and identification of trace gases in the atmosphere. Care must be taken, however, to compensate for the derivative features due to Fraunhofer lines where detecting atmospheric pollutants using backscattered sunlight.

B.7.3.4 STARTAP Approach

Another remote technique for determining atmospheric pollution on a global scale is the approach given the acronym of STARTAP.* It is based on the extinction of light from astronomical bodies. Preliminary research has indicated that analysis of stellar and solar spectrograms shows promise for identifying various molecular species and atmospheric pollutants. Analysis of atmospheric-extinction data indicates a very good correlation with atmospheric aerosol and particulate levels. With use of observations on file at observatories, it has become possible, for the first time, to determine global trends in particulate loading over several decades. The approach makes use of these data and specifies the potential exploitation of unique astronomical observing techniques as a means of providing atmospheric pollution data that may be otherwise unobtainable.

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*Proposal for Project STARTAP (Standardized Techniques for Atmospheric Research through Astronomical Procedures), P-321-7-71, Smithsonian Institution, July 1971.

ATTACHMENT B.7.4

Additional Information on Remote Monitoring Techniques For Water and Land Pollution

The remote surveillance of water surfaces has a history almost as old as the camera itself. Practically speaking, however, it was the scientific developments during and after World War II which placed remote sensing of land and water areas on a sound footing with the development of heat sensitive, or IR, film and radio frequency sounding techniques, or radar. More recently, other technological advances have broadened the scope of remote sensing instrumentation to include spectrometric, radiometric, passive microwave, multispectral and other selected techniques.

Historically, the primary basic monitor used for remote surveillance of water and land surfaces has been the camera and it is likely to remain so for some time because it is still the easiest, cheapest, simplest, and most versatile of remote monitors. Infrared film can readily distinguish between vegetation, bare land surfaces and water as can other conventional color and black and white films, and in addition it lends itself to evaluating thermal pollution, and to some extent, the biological productivity of lakes and streams. Photographic techniques have successfully been used in detecting underwater outfalls, plumes of light-colored effluents resulting from municipal waste treatment discharges, downstream eutrophication from waste discharges, and land drainage wastes which may include leaves and trash washed into streams and whose biological reduction by natural processes may induce deoxygenation. In addition, algae and other biological activity can be imaged very distinctly in IR film.

B.7.4.1 Multiband Camera

Representative of this class of instrument is the multiband camera. The synoptic multiband camera system combines the taking of a photograph of a very large scene along with the ability to discriminate between objects in that scene. This results from differences in reflecting the various optical wavelengths from sunlight illumination. Stereo images complete this capability.

The synoptic multiband camera system has uses in many applications areas for remotely monitoring water quality and land use conditions. Functional examples include multispectral photographic studies to identify coastal water radiance, water color, wave refraction, algal blooms, sedimentation and water luminance among others.

From identification of these parameters it is expected that several dynamic processes will be delineated, viz., coastal currents, biological communities, refraction patterns from shoaling waves and breaking surf, sea ice, etc. In addition, it should be possible to chart river effluent discharge patterns, shallow water sediment migrations, coastal topography, beach erosion, and shoreline changes. Examination of relationships between seasonal/climate changes and sea surface state for use in oceanographic forecasting should also be possible from these experiments.

These analyses are made possible because spectral differences in reflection have been shown to correlate closely with compositional and textural properties of material types thus providing a means of discrimination. Multiband (or multispectral) photographic techniques have been employed recently with considerable success for such discrimination from NASA, USDA, and USGS aircraft.

Other instruments operating in different regions of the electromagnetic spectrum have more recently been proposed for remote monitoring of water and land surfaces. Most of these are still in development or being used in field trials by NASA, USDA, USGS, and DOD as well as investigators in the Private Sector. Some of the more promising of these techniques are briefly described below and illustrated with specific examples.

B.7.4.2 Multispectral Line Scanners

Closely allied to photographic techniques in that the medium of record is film (or other heat sensitized surface) are multispectral line scanners which generally operate in spectral bands between 0.35u and 15u. This class of instruments is most useful in detecting heated effluents from power plants, industrial processes, monitoring surface temperatures of rivers, lakes, and streams and has been highly effective in detecting oil slicks in coastal waters and lakes. These instruments have the great advantage of operating during the day or night since the thermal IR region ($>$ 3u) is an emissive region and does not depend on the sun's reflected energy. Generally, these instruments are more costly to operate and maintain and frequently require a computer to analyze the raw data.

B.7.4.3 Microwave & IR Radiometers

In contrast to cameras and line scanners, radiometers, both microwave and IR are non-imaging monitors which measure emitted or reflected electromagnetic energy and display this information on a strip chart or magnetic tape. They operate in the same spectral domain as multispectral imagers as well as at microwave frequencies and are useful in recording spectral signatures of various objects and providing surface temperature measurements.

Considerable success has been obtained by NASA's Ames Research Center, for example, in detecting oil slicks through use of a radiometer and spectroradiometer they have developed. Based on the fact that ordinary sea water reflects blue-green (0.45-0.50u) light most effectively and has almost no reflectance at UV (0.38u) or red (0.6u) wavelengths while oil, on the other hand, has its highest reflection at 0.38u and 0.60u, the oil spills stood out dramatically at these wavelengths. In addition, it was discovered that the polarization of light reflected from the oil differed by about 25 percent from that reflected from the water.

Microwave radiometers have also been used for detecting oil spills and have also been employed for detecting sea ice, surface temperature, and salinity.

B.7.4.4 Passive Microwave Imagers

The passive microwave imager, in contrast to the radiometer, constructs a picture of a viewed surface such that the light and dark intensities displayed on the image are related to the amounts of microwave energy radiated by the objects in the scene. This is similar to photography but requires specialized apparatus to receive and record the longer, invisible wavelengths involved which are emitted by all objects as a result of their temperatures.

The passive microwave imager has the potential for providing EPA with complete stereoscopic brightness temperature maps of lakes, streams, oceans, etc. This information helps describe the large surface areas that can be rapidly covered by aircraft or spacecraft. Surface features detectable by this technique include surface temperatures and roughness, temperature gradients, and water-ice interfaces, among others. A lengthy list of exemplary applications for this instrument is presented in the March 1966 Prospectus for the Natural Resources Program published by NASA.

One passive microwave imager commonly used for remote monitoring utilizes state-of-the-art receivers having internal-noise outputs of about 1°K. On this basis temperature differentials of approximately 3°K will be detectable with a probability greater than 0.9. Estimates of anticipated temperature differentials to be encountered based on surface element differences in roughness and/or dielectric constants point toward expected differentials of 8°K or more.

One of the newer passive microwave imaging systems was developed by NASA's Manned Spacecraft Center. This instrument, operating at 10.69 GHZ, uses a two-dimensional phased array antenna to achieve scanning transverse to the flight path. The instrument converts microwave signals to electrical signals which modulate the control grid of a fluorescent tube. The varying light signals on the face of the tube are recorded on 35 mm black and white film. The great advantage of this imager, as with other microwave devices, is its all weather operational capabilities. A disadvantage is its poorer spatial resolution compared with conventional photographic systems. However, this instrument should be useful in monitoring large scale environmental changes during periods of inclement weather when other instruments are rendered inoperable.

In summary, the passive microwave imager provides an essential remote monitor component for monitoring environmental factors related to water surfaces yielding such information as thermal maps, surface structure, and inference on sub-surface features down to tens of centimeters depending on moisture or conductive content.

B.7.4.5 Altimeter/Scatterometer

Another useful monitor operating in the microwave region is the radar altimeter/scatterometer. This radar instrument produces onboard magnetic tape records whose informational content contains both measurements of the distance of the instrument platform to the Earth (altimetry), and the radar reflection properties of the Earth's surface structures at various angles of elevation from the vertical or nadir direction (scatterometry). This remote sensor operates at radio wavelengths of about 3 centimeters.

An alternate pulse of 4 microseconds width supplies the information on the radar reflection properties of ground surfaces; technically, the scatter cross-section of the ground structure illuminated out to an angle of 60° from the vertical.

By comparing records of a succession of pulses as the aircraft moves forward, a given patch of ground is viewed at different angles so that one can also derive how a given ground element changes its scatter ability with various aspect angles of illumination.

In addition, the altimeter/scatterometer is capable of transmitting and receiving horizontal and vertical polarizations. These are radio waves which generate electrical voltages which are maximum in a direction horizontal or vertical to the ground respectively. Such capability will aid considerable in interpreting water surface roughness.

B.7.4.6 Sidelooking Airborne Radar

Still another radar is the sidelooking radar which in addition to being a day/night sensor, is capable of functioning in all types of weather as well since it can operate at microwave frequencies which are located in the atmospheric windows. Although this sensor was not specifically designed for pollution detection, it is nevertheless effective in monitoring strip and pit mining operations as well as other large scale features of land and water surfaces. For example, sidelooking radar can also be used to monitor extent and changes in large industrial waste ponds and detecting oil spills.